Subterranea

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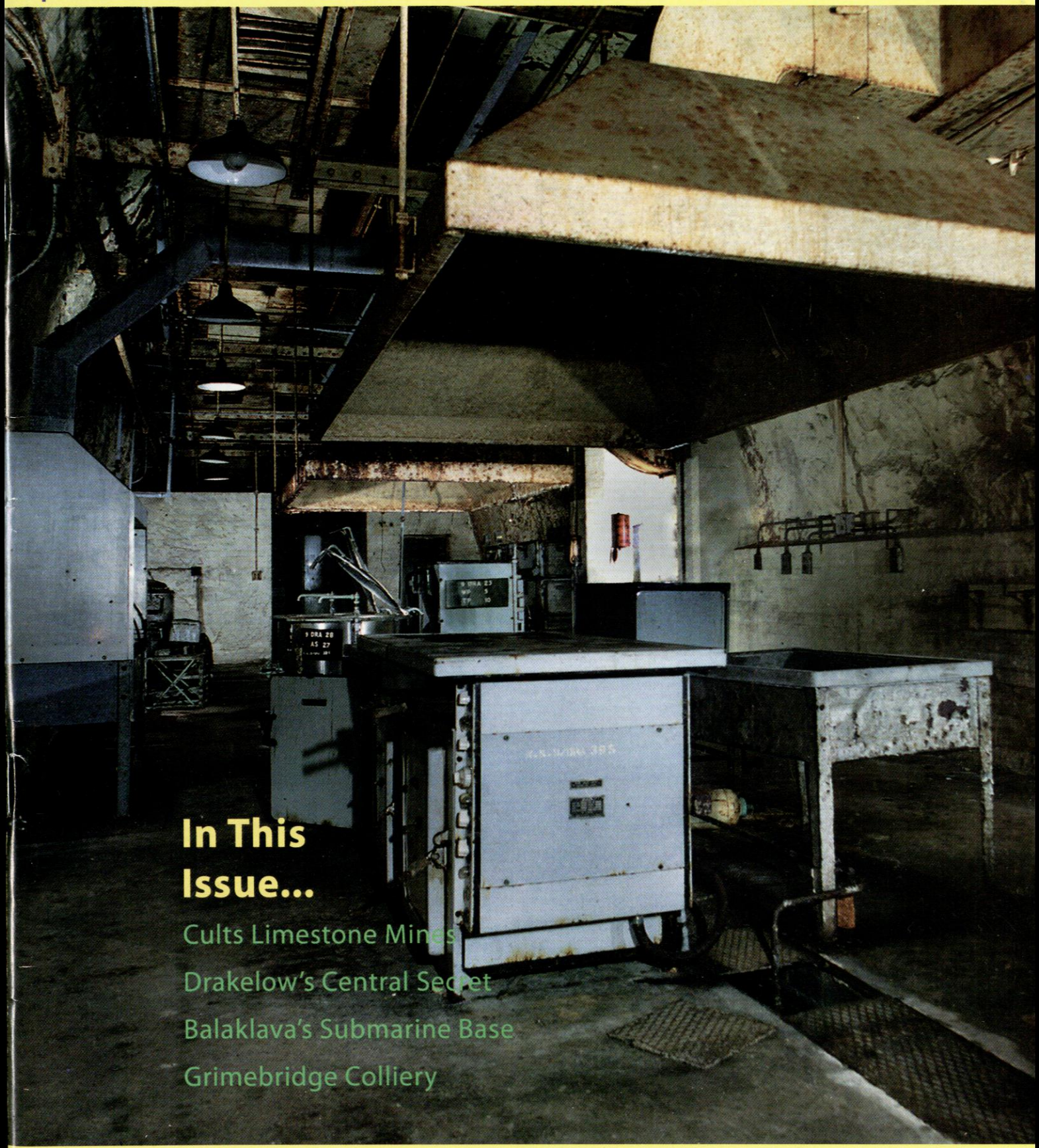

In This Issue...

Cults Limestone Mines

Drakelow's Central Secret

Balaklava's Submarine Base

Grimebridge Colliery

Subterranea Britannica

www.subbrit.org.uk

Subterranea Britannica is a society devoted to the study of man-made and man-used underground structures and the archaeology of the Cold War. In the case of military structures studies are entirely confined to declassified and decommissioned structures. The society is open to all and its membership includes all walks of life. Members are invited to contribute to this magazine even if this just means sending very welcome snippets from newspapers and magazines.

Editor: Nick Catford 13 Highcroft Cottages London Road Swanley Kent BR8 8DB
e-mail editor@subbrit.org.uk

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Front cover photo: The kitchen for the Regional Seat of Government at Drakelow. When the bunker was refurbished as a smaller Regional Government Headquarters this kitchen was abandoned and a new kitchen was provided. This would have been separated by a wall from LINSTOCK to preserve its secrecy.
Photo by Nick Catford

Back page upper: An intersection of passages near the working in the Grimebridge Top Bed Colliery in September 1995. The colliery closed completely on 4 July 1996 The galleries at this point are less than 5 feet in height.
Photo Nick Catford

Back page lower: Beyond the museum the Emergency 'Seat of Government' Bunker, Marienthal has been completely stripped of floors and fittings leaving the bare railway tunnel and a number of side tunnels, all equally bare.
Photo Robin Ware

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Newsletters of Subterranea Britannica are published by the committee of Subterranea Britannica. Original articles, book reviews, press cuttings, extracts from books and journals, letters to the Editor etc are welcome. However the Editor reserves the right not to publish material without giving a reason.

The committee of Subterranea Britannica and the Editor do not necessarily agree with any views expressed and cannot always check the accuracy of any material sent in.

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Chairman's Welcome

Martin Dixon

Most members will have noticed the recent 'refresh' of the Sub Brit website. The work, for which we are indebted to Richard Seabrook, has delivered a new 'home page' and navigation screens. It has also brought together the three sorts of site records (general, Cold War and ROC posts) into a single index – with access possible both by site type and via a powerful new map-based search.

In the background, but equally importantly, Richard has also masterminded the move of the website onto a new 'virtual private server' hosted by Linode. This gives us increased robustness, automated back-up and the capacity for future growth; it is even a little cheaper than our previous service into the bargain!

For every Sub Brit member who accesses the website, perhaps a thousand members of the public visit. It truly is Sub Brit's shop window, and attracts new members as well as increasing general awareness of our underground heritage. The work to date is just the first step of what we plan will be a range of future enhancements. Thoughts include the ability for members to post site reports and photos, a members' forum, an online shop for books and other goodies, and online membership management.

The priority of these future enhancements will be to a great extent determined by your feedback. That is why the current Sub Brit Members' Questionnaire is so vital. Your views on the website and on other Sub Brit activities will help shape the Society's future. A short proviso – our ability to do more (whether more of the same or completely new ventures) depends on finding members with the time and energy to take the lead on activities. The questionnaire also includes a section for members to volunteer their skills to help move Sub Brit forward.

So please, if you haven't already completed the questionnaire, then do so as soon as possible. I look forward to seeing the output and to the next chapter in Subterranea Britannica's story.

chairman@subbrit.org.uk

SUBTERRANEA BRITANNICA DIARY

Summary of Forthcoming Events 2011

Sub Brit specific events

5 May Open day at Paddock
to book a place email katy.bajina@networkhg.org.uk
6 – 9 May SB Europe Visits weekend – Sweden
1 July Deadline for Subterranea #27
2 July SB Committee Meeting
August (tbc) Ashley Road (Epsom) Deep Shelter open for SB members
End August Subterranea #27 published
2 – 5 September SB UK Visits weekend – Manchester
8 October SB Committee Meeting
15 October SB Autumn Day Meeting – London
17 March 2012 Hack Green open for SB members
September 2012 SB UK Visits weekend – Sussex

Other underground-related events

14 May Hindhead Tunnel walk-through
www.surreyhills.org/Hindhead-Together.aspx
10 – 13 June Institute Europa Subterranea meeting, Valkenburg
16 – 17 July SFES Congress, Haguenau (Alsace)
29 July – 1 August NAMHO Conference & Visits, Shrewsbury
www.namhoconference.org.uk
8 – 11 September Heritage Open Days across UK
17 – 18 September London Open House, including Paddock

For more information, email info@subbrit.co.uk or contact the Society concerned

NEWS – ARCHAEOLOGY

An admirable example of recycling, Cheddar Caves, Somerset

Our throw-away society could take a lesson from our forefathers of 14,700 years ago when it comes to implementing the mantra 'reduce, reuse, recycle'.

It has been suggested that prehistoric human skulls from Cheddar Caves have been used as cups or food containers. As coconuts are not known to have flourished in England at the time, and the arts of pottery had not yet perhaps been well-advanced, this seems an elegant solution to a need for containers for sloppy materials! Any skull would do, once its owner had no further use for it, whether defeated enemy or a deceased relative!

SOURCE: SAMPLE, Ian, 2011. Ice Age cups: how early man used his head. *The Guardian*, 17 February 2011, page 8.

Cowley Hole, Hillingdon, Greater London

In March 2009 the owners of a house built in 1954 in Cowley Road, Hillingdon, were surprised by the appearance of a hole in their back-garden lawn. This, on investigation, proved to be a brick-built cylindrical structure with a diameter of 1.4m, and a depth to a solid brick floor of 2.13m. The top, a dome built of half-bricks, had a central aperture with a diameter of 0.6m, and was 0.74m below the lawn. The bricks had been mortared, and the authors of the report make no mention of the interior having been rendered (to make it waterproof).

The hole had been backfilled, apparently as a single operation, with 19th- and 20th-century rubbish. No inlet or outlet pipes were found.

Historic maps showed a pair of cottages at this location in 1887, one of which had been used as a post office and (jointly) a bakery. The 16th-century *Crown Inn* still stands nearby.

The report (detailed below) regrettably does not tell us anything about the local geology, or the proximity below the lawn of the local water table. Consideration of these factors, and the mortared brickwork and the lack of interior rendering, would have a bearing on any discussion of the original purpose of the structure. Is it dug in permeable (gravel) or impermeable (clay) soil? The brickwork being mortared (although unlined) suggests the cavity was not intended for waste-water disposal into permeable ground. But the lack of a cement or similar lining suggests it was not to retain water. The lack of inlet or outlet pipes perhaps suggests water was not a consideration either way.

After discussing similar structures recorded elsewhere in Greater London, the authors of the report suggest that this feature may have been constructed for dry containment, perhaps ingredients for the bakery business, or valuables associated with the post office.

SOURCE: BOWLT, Colin, and Ken PEARCE, 2011. The Cowley Hole – what was it? *London Archaeologist* 12(11), 299 – 300.

Joep Orbons' current work at the Rijkholt flint mines in the Netherlands

Our member Joep Orbons, of Maastricht, runs (with a partner) a successful archaeological site investigation company, operating on behalf of public bodies or private landowners where artefacts, structures, and even holes in the ground may prove to be of heritage value. ArcheoPro 'archaeology, geophysics, prospections' is at *www.archeopro.nl.*

Most of what he does is non-interventionist archaeology, using geophysics devices and computers to build up a picture of what lies below ground. Apart from sinking augur holes, he tends not to do much if anything in the way of conventional excavation, although at what appear to be worthwhile sites that may follow. Reports on each site investigation are lodged in the public domain (in Dutch, of course!).

Most of Joep's work is on fairly ordinary sites in the Netherlands or Belgium, but a current project will be of some interest to SB members, as it concerns the prehistoric flint mines at Rijkholt, south of Maastricht. Members on the 2010 mainland Europe SB study weekend visited the concrete-lined tunnel driven by mining engineers through a sample of a whole nest of flint mines, at working gallery level, from which you can look through windows at the lighted crawling-height mine galleries.

The Rijkholt flint mines occur on the wooded crest of a chalk plateau overlooking the east or right bank of the river Maas. Joep and his team have examined adjoining areas, using geophysics, and produced evidence suggesting a considerably greater area of flint-mining than previously known. Excavation to confirm whether or not the features detected by remote sensing actually are flint mine shafts may follow in 2011. Associated surface features could yield information at least as important as may be discovered by re-excavating a shaft.

DETAILS: ORBONS, Joep, 2010. Vuursteenmijn en Michelsberg-nederzetting Rijkholt-Sint Geertruid

Gemeente Margraten Archeologisch-Geofysisch onderzoek Vervolgonderzoek 2010. Maastricht: ArcheoPro Archeologisch rapport 10129.

The mummies speak

Egyptian and other mummies, bodies deliberately preserved with chemical or herbal substances, can tell us quite a lot about life and death thousands of years ago.

Chemical analysis of preservatives can identify materials not known to occur anywhere near the place of burial. Importation into Egypt is indicated, and if likely source areas can be identified, international trade routes and patterns can be suggested. Examination of pigments used cosmetically or on coffins and tomb walls offers the same possibility.

A number of such pigments used, including antimony and arsenic of mercury compounds, are of very limited distribution in nature. And organic as well as inorganic materials are informative. For example, coniferous trees are not native to Egypt. Resins and waxes used in mummification contain compounds specific to certain species of conifer, which species will in turn be limited to particular locations in and around the Mediterranean area.

The Egyptians practised mummification from around 2649 BC to the seventh century AD.

SOURCE: DAVIES, Emma, 2011. Mummy mania: mummified remains from Egypt and beyond hold chemical information about the daily lives of ancient civilisations. *Chemistry World*, 8(2), 48 – 51.

NEWS – CONSERVATION, HERITAGE AND TOURISM

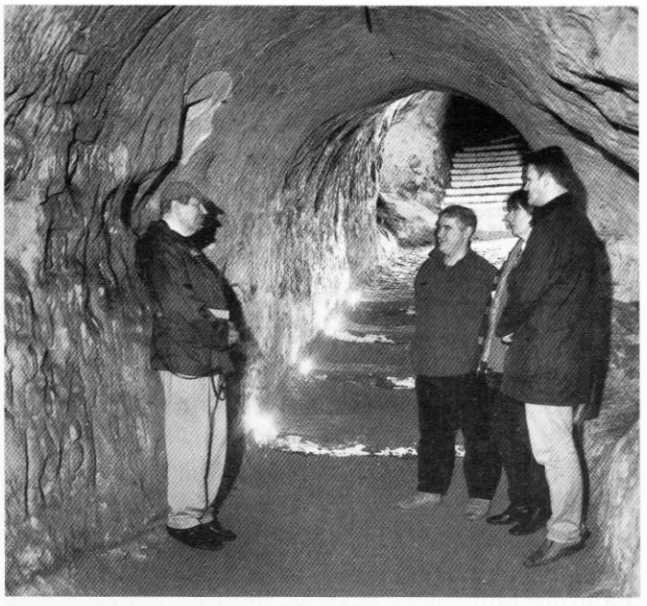
Reigate Cave Open Days 2011, Surrey

The Wealden Cave and Mine Society (*www.wcms.org.uk*) will be opening three of Reigate's town centre 'caves' and offering public guided tours on five Saturdays in 2011: May 14, June 11, July 9, August 13, and September 10, all from 09.30 to about 16.00hrs. A small charge is made for admission.

The 'caves' are of course not natural caves at all, but entirely man-made at various dates.

[1] The so-called 'Barons' Cave' lies within and below the impressive earthworks of Reigate Castle, now a town-centre public park. All original upstanding masonry has long since been robbed from the castle, but the dry and wet moats survive, as does the 'Barons' Cave' an enigmatically very carefully sculpted through tunnel from within the former inner bailey to an exit (now the main entrance) in the dry moat.

Whilst the traditional tale that this was the clandestine meeting place in 1215 of the Barons who persuaded King John to sign Magna Carta at Runnymede is almost certainly a fiction (albeit first recorded at least as early as the 1690s), the castle is known to date from the latter part of the twelfth century (1180s) and the first known reference to the cave is in Camden's *Britannia* of 1586.



Reigate Caves – Barons Cave. Photo Nick Catford

There is an astonishingly large and equally carefully shaped 'hall' leading off from the tunnel, and is the supposed meeting chamber.

The 'cave' has been a tourist attraction for some centuries, with graffiti carved in the sandstone walls from the seventeenth century onwards. The guides point out all the salient features, explain what little is known for sure, and recite the several theories concerning the excavation's original purpose. Not only a good 'Whodunnit' but an equally good 'Whydidtheydoit'! Lighting during the guided tour is by hand-held lanterns.

[2] Tunnel Road West sand mine is entered via a doorway within England's oldest surviving road tunnel (now pedestrianised), driven in 1820–24. This mine is one of some half a dozen still-accessible industrial-scale sand mines under the town centre, and may in part predate the road tunnel. In its innermost recesses, below the Castle, there is an impressive underground landscape of pillar-and-stall workings, with tunnels up to four metres wide and five metres high. A large walled-off area is the site of a dramatic mine collapse in 1858.

It seems likely that after this date subterranean mining of silver sand (for glass manufacture in London) was abandoned in favour of opencast sand pits around the edge of the then built-up area. The subsidence crater in the public park above is now an attractive 'sunken garden', with nothing to explain its dramatic origin. Secondary uses of this town-centre mine include beer, wine and spirits storage; World War II air-raid shelter use; and the current subterranean rifle range. The West Mine is not normally readily accessible, as a part is occupied by a rifle club, to whom WCMS is grateful for allowing occasional access. This site is electrically lit throughout.

[3] Tunnel Road East sand mine is also entered from one of the several doors in the wall of the Tunnel Road tunnel. The mining styles (several within a single small

mine) contrast strongly with those in the west mine, with smaller mine galleries and much brick-built support. The original rectilinear pillar-and-stall mine layout has been somewhat obscured by numerous inserted brick supports and dividing walls, dating from reputed use as Army storage in World War I, as shelter and commercial usage in World War II, and other uses. Much of the sand here is of very inferior quality (containing too much iron-stained sand) for clear glass manufacture, and there is no doubt that one area at the south end is a purpose-dug wine cellar.

This mine is electrically lit, and contains the beginnings of a subterranean museum featuring, inter alia, one of Surrey's pioneer horse-drawn mineral railways; east Surrey mineral industries; and World War II and the Cold War in Reigate.

On sale during the public open days are several of the Wealden Cave and Mine Society's postcards (featuring the Barons' Cave) and booklets about underground Reigate and east Surrey.

All three sites are within a minute or two's walk of Reigate High Street, and easily visitable by adults and even very small accompanied children, with no special dress or equipment needed. Needless to say, there is a choice of cafes, pubs and restaurants around the corner!

National Heritage Protection Plan

The National Heritage Protection Plan (NHPP) is the new framework for bringing together work by English Heritage and other conservation-sector partners to protect the historic environment. The draft four-year plan has been published on the EH website at *www.english-heritage.org.uk/nhpp* and further input is sought before it becomes operational in April 2010 (it says in the source cited – presumably meaning 2011). A Review Board of 'external stakeholders' is to be set up, and the plan reviewed each year.

It might be represented to EH that the stalled Monuments Protection Programme assessment of the quarrying industry should be a high priority: it got as far as prioritising sites (including quite a few underground building-stone quarries) as deserving Scheduled Ancient Monument status, but ground to a halt through lack of funds. Surrey, potentially, would have gained at least two or maybe three new SAMs – Chaldon, Godstone, and Merstham quarries.

SOURCE: IMPEY, Edward, 2010. *National Heritage Protection Plan*. English Heritage Conservation Bulletin 65, page 41.

English Heritage Archives Catalogue online

An English Heritage website was launched in March 2010 allowing access without charge to catalogues describing more than a million photographs and other documents held in the EH archive at Swindon. The catalogues can be accessed via *www.englishheritagearchives.org.uk*. The new facility is reportedly very easy to use, and makes it very easy to order copies of documents or photographs. User feedback on the new site is solicited.

SOURCE: ENGLISH HERITAGE, 2010. English Heritage Archives catalogue online. English Heritage Conservation Bulletin 65, page 44.

Britain from Above: the Aerofilms collection

In 2007 English Heritage acquired an archive of over one million aerial photographs made between 1919 and 2006 by Aerofilms. With Heritage Lottery Funding of £1.7m, EH in partnership with the Royal Commissions on Historical Monuments for Scotland and Wales is over the next four years conserving 95,000 of the oldest and most valuable of these images, making them freely available online.

The *Britain from Above* project is based at the National Monuments Record at Swindon (the EH public archive). Free email updates on the progress of this project can be had from *aerofilms@english-heritage.org.uk*.

SOURCE: ENGLISH HERITAGE, 2010. *Britain from Above*. English Heritage Conservation Bulletin 65, page 45.

Celebrating Edge Hill, Liverpool

A Society has recently been founded to promote the historical heritage of the railway at Liverpool's Edge Hill.

Edge Hill station is the first stop for trains out of the city terminus at Lime Street. A station has existed hereabouts since September 1830, hence its claim to be the world's oldest surviving passenger station still in use. Passengers, however, see only the island platforms and stone station buildings. A single line branching off on the south side, now used only for stabling trains not in service, runs into the spectacular Chatsworth Street cutting, well-known from published views of the opening of the Liverpool & Manchester Railway.

Edge Hill Cutting. There are three tunnels, that on the left is used for stabling trains overnight. In the centre behind the bush is the Wapping tunnel, with the Crown Street tunnel just visible on the right. Photo Nick Catford

The near-vertical sandstone walls of this cutting have a number of rooms cut into them, and these and other cavities have been investigated archaeologically and shown to be related to an early cable-haulage system. Even more interestingly, at the far (west) end of the cutting there are two disused tunnels.

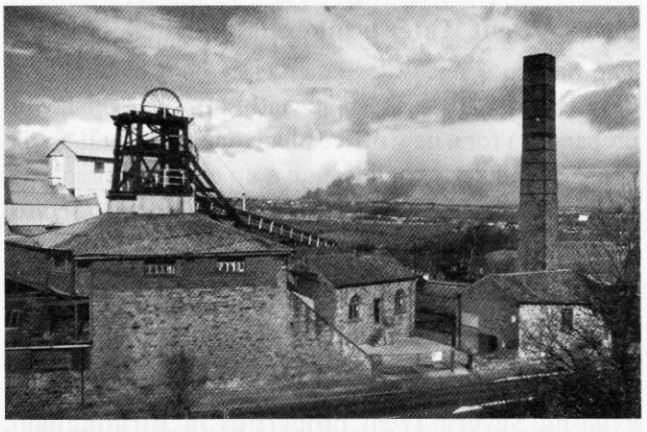
The shorter one, on the right, rises towards its blocked western end, beyond which was Liverpool's original Crown Street terminus. The left-hand tunnel, of 2,057 metres, is the Wapping tunnel, which served freight traffic to and from the docks. Another long disused tunnel (the Waterloo tunnel) exists on a line diverting from the north side of the modern station and served another docks area. The present line in traffic down to Lime Street station was originally tunnelled, but has since been extensively opened out to a steep rock-sided cutting.

The Chatsworth Street cutting has not been accessible to the public since, briefly, the 150th anniversary of Britain's railways. Edge Hill, of course, is also famous as the scene of Joseph Williamson's bizarre tunnelling activities. The Friends of Williamson's Tunnels, and the Joseph Williamson Society (which has a Williamson's tunnels visitor centre), seem increasingly to be working in collaboration rather than as rivals. To what extent the new Society will work with both of them will be interesting to see. It has been claimed that making the cutting to Lime Street resulted in the contractor's men accidentally breaking into one of Williamson's tunnels!

SOURCE: ANON, 2010. Promoting Edge Hill. *Modern Railways* 67 (747), page 35.

National Coal Mining Museum for England under threat, Caphouse Colliery, near Wakefield, Yorkshire

The Department for Culture, Media and Sport (DCMS) proposes hugely reduced if not totally withdrawn funding for seven English museums, including the National Museum for Coal Mining at Wakefield and the Museum of Science and Industry in Manchester. Central Government funding is to be reduced, and cease altogether in four years' time. The museum at Wakefield, which features a visit into real colliery mine galleries, faces the loss of £2.8m from its budget of £3.2m. A merger with the Science Museum (which already has its Railway Museum part at York) has been suggested. The local council is unable to help.



This is depressing news, following as it does the closure of the Chatterley Whitfield Colliery (where underground tours in real mine galleries were once also on offer) and of the coal mining museum at Salford.

SOURCE: WALKER, Peter, 2010. Local museums face funding crisis. Seven institutions will lose up to 80% of income. Losers include Horniman and coal mining museums. *The Guardian*, 18 November 2010, page 7.

NEWS – HEALTH AND SAFETY

South Eastern Cave Rescue Organisation exercises, Surrey

The South Eastern Cave Rescue Organisation (SECRO) is a loose affiliation of caving and related clubs in southeast England.

In the event of the ambulance, fire or police services being called to an 'underground incident' in the area, equipped and experienced members of the several constituent bodies (of which the Wealden Cave and Mine Society (WCMS) is one) turn out (often through the small hours of the night) to assist in the search for people lost, and possibly injured or even dead, underground. Fortunately, although a number of persons lost (lights failed and so forth) underground in Surrey have been located and guided out, there have to date been no serious injuries or deaths.

On the two occasions when the author of this note (PWS) turned out at or about midnight, the missing persons were not experienced cavers. One group was a small party of teenagers lost in the Godstone Hill quarry tunnels (something like eight miles of them) under the A22 between Godstone and Caterham. The other was a group of scouts, and their leader, lost in the Chaldon–Merstham quarries labyrinth (around ten miles of low tunnels) to the east of Merstham. Fortunately, there were no casualties. But in each case the groups appear to have been ill-equipped and inexperienced, and not adopting a rational and safe approach to exploring a large and complex system of (to them) unknown extent.

Since WCMS has now, in collaboration with landowners and occupiers, made most east Surrey mine entrances secure, rescue call-outs are now rare. Persons wishing to go underground can do so with WCMS guides, and WCMS members can have sets of keys. These arrangements reflect land owners' and occupiers' wishes.

Nevertheless, unauthorised persons (potentially jeopardising access agreements) have broken in from time to time, and risk (at best) getting lost and needing to be rescued. Thankfully, although some of the east Surrey mines are known for instability and roof-falls, there are to date no recorded modern (since mine abandonment) instances of death or injury in any of the Surrey mines.

Nevertheless SECRO arranges rescue practices every so often – on two occasions in 2010. These have been reported in the latest issue of the WCMS newsletter *News of the Weald*.

These exercises have followed a variety of scenarios. In one your reporter was required to act as an irresponsible teenager (type-cast?) and tasked to drop off the end of

what others in the group thought was a routine underground visit, and lose himself as quickly and thoroughly as he could to test search procedures. Although his route and hiding place were adopted only there and then, he was successfully located in a remarkably short time, given that the whole system has virtually no walking-height tunnels, and has numerous long dead-ends and low crawls.

The 'victim', by the way, may not know he is to play the lead role until the very last minute. On another occasion it was decided to stretcher-out the biggest and heaviest of those present: I can vouch for the fact that carrying Nick Catford out of a low barely crawling-height tunnel strewn with rocks is hard work and, from Nick's point of view, distinctly uncomfortable!

The two exercises in 2010 were to check that it is possible to retrieve a person strapped on a stretcher via a very low and wet and muddy rock-filled passage, and up a 16-foot deep shaft and out of the manhole at the top. These exercises have been described by Peter Burgess, Graham Christian and Paul Fairman in the articles cited below.

SOURCE: BURGESS, Peter M., 2010. First 2010 SECRO exercise, Bedlams Bank, 4 July 2010. *News of the Weald* 80, 4 – 5.

SOURCE: CHRISTIAN, Graham, 2010. Second 2010 SECRO exercise, Bedlams Shaft: the underground, 17 October 2010. *News of the Weald* 80, 6 – 7.

SOURCE: FAIRMAN, Paul, 2010. Second 2010 SECRO exercise, Bedlams Shaft: the surface bit, 17 October 2010. *News of the Weald* 80, 5 – 6.

NEWS – MILITARY AND DEFENCE

Drunk in charge of military nuclear material, USA

Federal agents whose job it is to move nuclear weapons and components around the USA have been discovered, on occasion, to be suffering from a surfeit of imbibed alcohol whilst so employed. This is a finding by the Energy Department's Inspector-General, who has highlighted sixteen incidents during the period 2007–2009 giving cause for concern. Nearly six hundred personnel are engaged in effecting the transits.

SOURCE: ANON, 2010. Federal agents drunk in charge of nuclear material. *The Guardian*, 24 November 2010, page 22.

Crimean War bunker discovered in Australia

Williamstown (a suburb of Melbourne) now lays claim to one of the country's oldest military bunkers after one dating back to the 1850s Crimean War was discovered at the cricket ground in Morris Street. The bunker and tunnel were uncovered during redevelopment at the Williamstown Cricket Club this January. The bunker is believed to be part of the Port Phillip Bay defences dating back to the 1850s.

It lay exposed until the 1920s when it was backfilled, and was consigned to history during construction of the grandstand in 1930. Hobson's Bay Council said army personnel had visited the bunker and confirmed that it was probably used to store artillery in the 1800s.

It is believed the bunker was built from bluestone, possibly excavated by prisoners kept on prison hulks moored in Hobson's Bay.

Bushranger Ned Kelly spent several months on board the prison ship *Sacramento* in 1873–74 and worked ashore breaking stone for local infrastructure. There is a lingering rumour that he played football with the Williamstown Reserves during that time.

The Hobson's Bay military bunker will be protected under the Heritage Act, which makes it an offence to knowingly damage, disturb or excavate the site without permission from Heritage Victoria. The location of the bunker means it is unlikely to interfere with the cricket club's Aus$8 million expansion.

The council is investigating the origins of the bunker, in collaboration with Heritage Victoria and a historical interpretation consultant, to determine the best options for preserving or restoring it.

SOURCE: *Hobson's Bay Leader* (Australia) 1 February 2011.

Severn Trent Water bunker demolished

The Severn Trent water emergency control bunker at Shrewsbury (Shelton) has recently been demolished in preparation for a new office block due to be built on the site. The bunker was didn't give up easily and required diamond saws, excavators and rock breakers to reduce it to rubble which was then tipped back into the hole.

Shelton was one of eight emergency control centres built in the late 1980's. Although all were completed none of them were fully fitted out and commissioned following the end of the Cold War. The bunkers were located at existing Severn Trent properties in Birmingham, Gloucester, Derby, Warwick, Leicester, Shrewsbury, Stoke on Trent and Nottingham.

SOURCE: Pete Turier, Severn Trent Water.

NEWS – MINES AND MINING

Delays in reopening lead to job losses at South Crofty Mine, Cornwall

A quarter of the workforce at the Cornish tin mine has been laid off while haggling continues over a land swap which could clear the path for it to be reopened.

Western United Mines (WUM), the owners of South Crofty Mine in Pool, near Camborne, have confirmed that sixteen workers out of a staff of sixty have been made redundant in a cost-cutting drive. The firm is hoping to reopen the tin and copper mine, which was Europe's last when it shut in 1998.

However, a spokesman said that while it was confident the mine would eventually reopen, current planning issues had caused a cascade of delays and the firm now needed to reduce outgoings.

Photo Nick Catford

The move follows a need to significantly reduce operating costs whilst awaiting the outcome of planning decisions and other matters concerning the relocation of the mine site. WUM's confidence in the resource potential of South Crofty remains undiminished and they look forward to progressing plans for the re-establishment of production at the mine.

The project to bring South Crofty back to life has already seen an investment of more than £12 million and ambitious plans have been aired to eventually create 1,000 new jobs and see vast areas of land turned over to housing and employment.

Last year it emerged that gold deposits had been discovered at the mine, along with copper, silver and zinc. Deposits have also been found of the valuable mineral indium, which is used extensively in IT hardware.

In August 2010, WUM submitted two planning applications for the site, one for the relocation of surface buildings and the second for an extension to the mining permissions that will more than double its underground operating area. It represented a major step forward for the company, which purchased the defunct mine with its rich seams of mineral wealth a decade ago.

WUM has been working with Cornwall Council and CPR Regeneration, covering the Camborne, Pool and Redruth corridor, on a framework plan to drive the project forward.

The company and council had planned to swap land which would allow the continuation of a vital link road in the area and free land for the construction of the new surface buildings for the mine.

It had been hoped that the planning applications would be determined by last autumn, with preparatory work going ahead early this year and mining production due to start next year. However, the negotiations are still ongoing.

SOURCE: *The Cornishman,* 17 January 2011.

The Milwr Tunnel, Flintshire

For rather more than two years, United Utilities, the water company which owns the Milwr Tunnel, has closed the complex to all visits whilst they carry out safety checks and associated remedial work. We understand that they have now received the engineers' report but we have still not heard about access. Hopefully this will be re-established. If it is, there will be a period during which the Club will have to make its own assessment of the safety of ladders, platforms, rail track and tunnels, etc. before taking visitors and club members into the system. It is likely that such inspections and remedial work would take some months. While it is not possible to give any date, the Access Officer will let Subterranea know if and when entry is possible The Club does not have a website at present but contact may be made through Sub Brit or the Access Officer, Stephen Brown S_G_Brown@tiscali.co.uk.

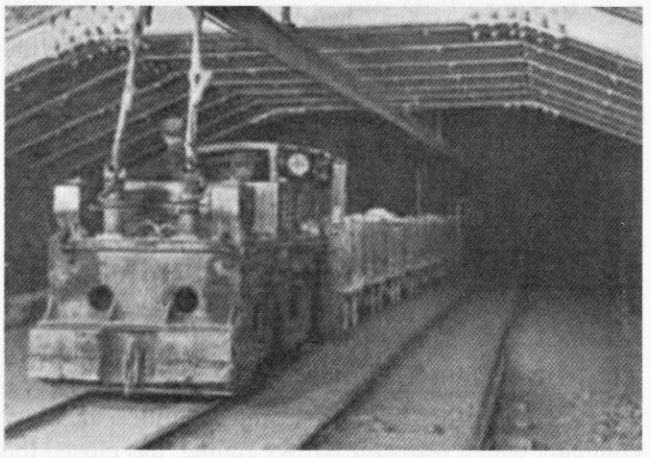
SOURCE: Grosvenor Caving Club

Manrider in the Milwr Tunnel. Photo Nick Catford

Billingham Anhydrite mines plan is approved, Stockton-on-Tees

The green light has been given to dump hundreds of thousands of tonnes of hazardous waste in Billingham's Anhydrite mines.

Stockton Council's planning committee voted 7 to 5 to accept NPL Waste Management's application to reopen the mine for the storage of non-toxic waste, including industrial ash.



Billingham Anhydrite Mine. Photo from Jimbo

Three thousand people signed a petition against the plans after they were first revealed in 2007. But the planning committee heard yesterday that there were only 27 objections after NPL put in the application last year. The company carried out extensive public consultations and committed to enter a legal agreement that no nuclear waste would be stored in the mine.

The plans will see the conversion of about a third of the mine to a four-million-cubic-metre waste storage facility, storing 100,000 tonnes of waste a year, delivered by HGV road tankers. The construction of the project is expected to create up to fifty jobs, with up to thirty jobs created during its operation.

Objectors' concerns included the town being used as a dumping ground and health worries as well as questions about what happens once the small section of mine is full.

SOURCE: *Billingham Evening Gazette,* 11 March 2011

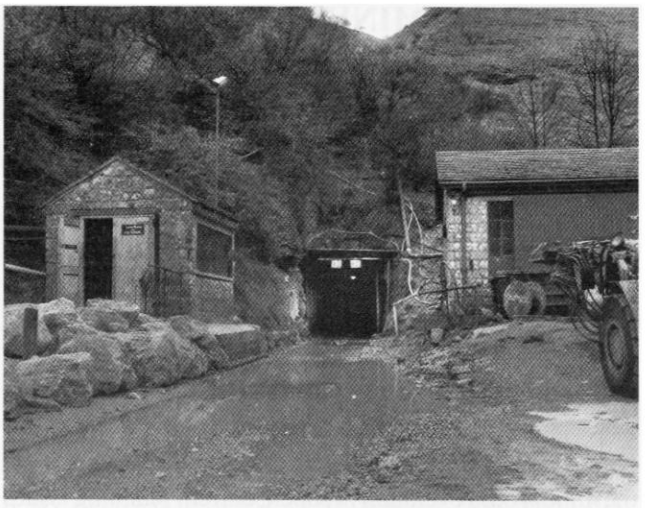
UK's last fluorite mine to close, Derbyshire

Fluorite (calcium fluoride) is our principal source of fluorine, an element essential in all sorts of things from toothpaste to non-stick frying pans and aluminium smelting.

It is one of the gangue (surrounding waste) minerals occurring in and alongside ores such as galena (our main lead ore). Until modern times, many such gangue minerals have been tipped to spoil, and many mine tips have later been reworked to extract them.

The Peak District of Derbyshire has seen a number of fluorite mining operations over the years, and in fact recently lead has been a by-product of gangue minerals mining, rather than the other way round.

Now, however, our last fluorite mining and processing operations are coming to an end: future needs will have to be met from imports. A firm in Mexico will supply fluorite or fluorine compounds from non-British sources. Glebe Mines Ltd is to discontinue extraction at Watersaw Mine on the Hucklow vein under Longstone Edge. Sixty-



Watersaw Mine - Sallet Hole No. 1 adit. Photo Nick Catford

five jobs in Derbyshire are lost, with more at the associated chemical plant at Runcorn.

SOURCE: ANON, 2011. Peak district fluorite mine to close. *Down to Earth* 74, page 7.

Safety measures in coal mines in China

Chinese collieries have a shocking safety record but after several years of falling accident rates, there has been a reversal. In 2009 there were more than 2,600 deaths, down from a peak of almost 7,000 in 2002. However, the 1261 recorded deaths in the first half of 2010 are an increase on the 1175 during the same period in 2009.

It has been reported that if mine managers were to spend more time underground, more attention to rules and regulations would be paid, and accident rates reduced. However, it appears that ordinary miners are being given 'manager' job titles, with senior managers continuing to stay in their above-ground offices.

SOURCE: BRANIGAN, Tania, 2010. Sudden promotion gives Chinese coal miners that sinking feeling. *The Guardian*, 22 September 2010, page 24.

Will mining landfill become a necessity?

We obviously no longer expect expensively purchased devices to last. Anything and everything from mobile phones to computers and cars is, it seems now, disposable. We are all constantly urged to buy new ones, and discard the old.

But a lot of the modern world's wonderful new toys rely on scare mineral resources. A recent study has suggested that some sources for eight strategically crucial metals, and also helium, are in serious danger of being exhausted within a century. The metals or metalloids are zinc, gallium, germanium, arsenic, silver, indium, tellurium and hafnium. Several of these are vital in electronics devices, and indium for example is needed for computer and mobile phone screens.

Also under threat from increased usage (and increased disposal to the rubbish bin) are ruthenium, rhodium, tantalum, osmium, iridium, platinum and uranium. So relying on nuclear fission to solve the world's energy crisis

and carbon footprint problem could be foolish. Added to which, the magnets essential to new generations of wind turbines call for the use of significant tonnages (largely supplied from China) for some of the lanthanide 'rare earth' metals.

And over twenty other metals, including some quite familiar to those not having a strong knowledge of chemistry, have limited economically exploitable resources. Leaner and leaner ores of chromium, cobalt, copper, tin and lead, amongst others, will have to be worked at greater and greater expense if supplies are to be maintained. And digging up landfill sites to separate enough indium from all the other junk isn't going to be cheap!

SOURCE: DAVIES, Emma, 2011. Critical thinking: as our supply of some essential elements dries up, it's time to start urban mining. *Chemistry World* 8(1), 50 – 54.

NEWS – MISCELLANEOUS

New storm drain in Manchester

Deep under Chester Road in Manchester is a brick-lined drain dating back to the beginning of the last century. Big enough for two Transit vans to drive side by side, it carries Manchester's famous rainwater away from the city centre, preventing roads, homes and businesses from flooding.

Now United Utilities is planning a £7 million project to upgrade the storm drain, helping clean up the Manchester Ship Canal – the water's final destination.

The water company plans to build an underground chamber the size of a warehouse around the brick structure. It will house three-metre-tall screens to strain out the rubbish and sanitary litter that would otherwise end up in the canal.

Although most of the construction will eventually be hidden underground, there will be a small compound and control kiosk above ground on Hulme Hall Road.

If plans are approved United Utilities expects work to start this summer, with a completion date in autumn 2012. This is one of many projects being carried out by United Utilities between 2010 and 2015 as part of a £3.6 billion investment to improve drinking water and the environment throughout the Northwest.

SOURCE: United Utilities website, 2 March 2011.

Underground base could be built on the moon

Though President Obama may have cancelled NASA's mission to the Moon, that doesn't mean the reasons to go there and establish a base aren't continuing to add up. The latest comes via the Indian Space Research Organization who may have discovered a unique geological feature on the moon that would make building a lunar base easier.

The organization has discovered a giant underground chamber near the moon's equator in an area referred to as the Oceanus Procellarum. The discovered chamber is much longer than the vertical moon hole found in 2009 by the Japanese Space Agency (JAXA) which could house a small lunar base. Instead, the new chamber could house a small lunar city due to the fact that it's one mile long and 393 feet wide.

The new cave was discovered by the Chandrayaan-1 spacecraft which was India's first unmanned lunar probe launched in 2008. Chandrayaan-1 also assisted in the discovery of water on the moon in September 2009 through the use of NASA's Moon Mineralogy Mapper.

By utilizing the existing underground geography on the moon, a lunar base could be established much more easily due to the fact that the environment is more constant compared to the lunar surface which might see fluctuations of temperature between 266 degrees and -292 degrees Fahrenheit. In comparison, the newly found lava structure stays a consistent –4 degrees Fahrenheit. Another advantage is that the structure would provide natural protection from radiation, impacts, dust and extreme variations in temperature.

SOURCE: website *http://www.geekosystem.com/moon-cave/*, March 2011.

Geothermal hot water for Newcastle-upon-Tyne

Drilling has commenced in Newcastle-upon-Tyne as the first part of a district heating scheme which is to tap water at 80°C from a depth of 2,000 metres. Hot water is expected to be pumped up to the city centre by June 2011. A new Science Centre on a former brewery site is to be supplied, as well as 140 shops in the Eldon Square shopping mall.

SOURCE: WAINWRIGHT, Martin, 2011. Newcastle gets into hot water. *The Guardian*, 24 February 2011, page 13.

Unrest underneath Beijing, China

Many members will remember Hilary Shaw's talk on underground Beijing a few day-conferences back. The city has numerous sub-surface Cold War air-raid shelters in a run-down quarter, numbers of which are tenanted as inexpensive if tiny homes, or used as cheap hotels. The occupiers are largely the lowest paid and often immigrant workers. Protest marches and demonstrations have been reported.

Networks of tunnels and shelters extend from the Central Government district of Zhongnanhai out to the countryside towards the Great Wall. Other, isolated shelters exist below apartment blocks.

SOURCE: WATTS, Jonathan, 2010. Landlords of subterranean Beijing protest against clearout. *The Guardian*, 31 December 2010, page 20.

NEWS – TUNNELS AND TUNNELLING

Tunnel at Wimbledon, Southwest London

One Mick Burnell has reported as follows on 'a large old house in Wimbledon' where he had been employed on work for a building company. At this property, a hole 'had appeared' in the lawn.

There were the totted remains of a wooden cover, and an approximately three-feet diameter brick shaft with step-irons down one side. At a depth of about twelve feet the vertical shaft communicated with a tunnel running both ways. This was of the order of four feet high, brick-vaulted and with a brick floor. In one direction the tunnel was followed for 'about a hundred yards' to a blockage resulting from a collapse.

In the opposite direction, the tunnel led (reportedly at a greater distance) to a junction, beyond which the left-hand continuation was blocked, but that on the right led to a small opening to daylight which proved to lie within Wimbledon golf course. The only clue to the property reported is that the owner of the house, at the time of this discovery, was the then Mayor of Wimbledon.

SOURCE: WINDER, Paul, 2010. Caterham well fatality, and tunnels at Wimbledon. *News of the Weald* 80, 3 – 4 [reporting information from Mick Burnell]

Abandoned tunnel found in the grounds of a Scottish hospital

A brick-lined tunnel links a derelict mansion and ornamental loch which forms part of the estate of the new Forth Valley Royal Hospital in Falkirk. Ranger Gordon Harper made the discovery while clearing rhododendron bushes on the loch's shore. It is thought the tunnel would have allowed wealthy guests staying at Larbert House two hundred years ago to avoid staff on the walk to the loch.

The hospital, opened in August 2010, is clearing the 70-acre estate to turn it into a 'woodland oasis'. A Forestry Commission Scotland ranger was appointed earlier this year to look after the grounds.

The tunnel was first thought to have been part of a ruined boathouse. Geoff Bailey, keeper of archaeology at Falkirk Council, said the 'fantastic' tunnel – dating from about 1800 – was likely to have been built to preserve the privacy of the gentry.

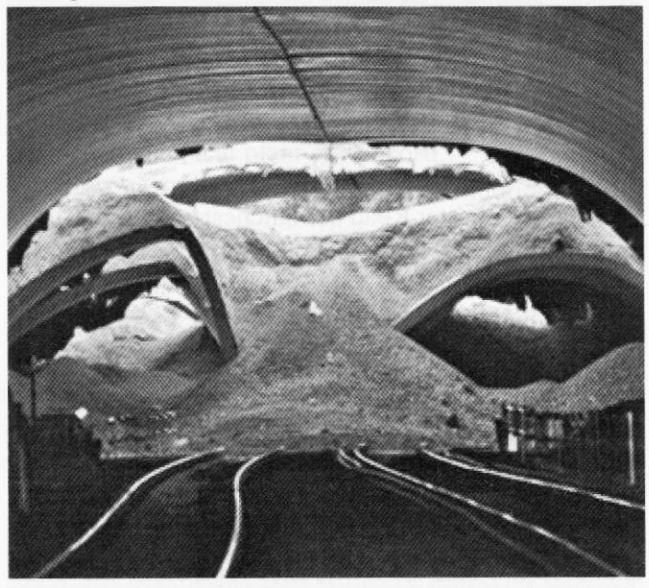
Larbert House, a Category B listed building, was the residence of the Stirling-Chalmers family for many years. It was designed by David Hamilton and built for Sir Gilbert Stirling in 1822. The house lay derelict for several years and was badly damaged by fire in 2006.

SOURCE: BBC News Tayside & Scotland, 11 March 2011

Tesco supermarket has opened above the cut-and-cover tunnel at Gerrards Cross, Buckinghamshire

The railway cutting near Gerrards Cross station has been roofed-over to allow the construction of a supermarket above the lines. This opened in November 2010. The 319-metre 'tunnel' made national headlines when a part of it collapsed in 2005, to the great inconvenience of rail passengers on this main route to Banbury and Birmingham.

SOURCE: ANON, 2010. Tesco opens above Chiltern line. *Modern Railways* 68(748), page 9 [January 2011 issue published December 2010].



Closure and destruction of Whitwell railway tunnel, Derbyshire

Whitwell tunnel (about 500 metres in length) lies on the Nottingham to Worksop railway line, the passenger trains thus passing close to such well-known underground sites as the Welbeck Abbey tunnels of the 5th Duke of Portland, and the caves and their Ice-Age art at Creswell Crags.

The tunnel passes through a mass of dolomitic (rich in magnesium carbonate) limestone, a valuable mineral resource. The international Lafarge company is engaged

in working this deposit by opencast quarrying, and has proposed extending operations through the hill in which the tunnel was bored in 1875. If this suggestion is acted on, an alternative surface line would be constructed about 70 metres to the south of the tunnel.

SOURCE: ANON, 2011. Railway diversion project proposed for Whitwell. *Down to Earth* 74, page 7.

The Scotland Street tunnel is set to be reopened as a facility for local youths

Edinburgh World Heritage is supporting plans for much needed youth facilities at the historic site of Scotland Street Tunnel, within George V Park, in the northeast of the New Town.

In 2008 the community group Friends of George V Park, with the support of the City of Edinburgh and Lothian & Borders Police, proposed the Tunnels Youth Project to address a shortage of facilities for young people in central Edinburgh. The tunnel dates back to 1847 and connected Scotland Street Station to Waverley as part of the Edinburgh to Granton line, from where the world's first railway ferry linked Edinburgh to Fife. EWH provided a grant in support of the first phase which saw the tunnel entrance reopened and a sheltered area created in its mouth with a new metal security screen.

Photo Nick Catford

As a category B listed structure it is important that the project is set within a clear conservation policy. Future plans include a bespoke, dry and well lit youth shelter within the tunnel space, as well as enhanced recreational and sports facilities within the adjoining park. A grant from Edinburgh World Heritage and a donation from Diageo has now allowed a Conservation Statement on these plans to be commissioned.

The completion in March of the Conservation Statement allows the project leaders to pursue the next steps in achieving their vision with confidence.

SOURCE: Edinburgh World Heritage web site 30.3.2011

Tunnelling contracts awarded for Crossrail, London

The construction of Crossrail, the proposed main line rail tunnel east-west under central London, appears now to have reached the point of no return. Contracts have been awarded (on 10 December 2010) for excavating the main running tunnels, and for commencing work on new sub-surface stations.

The first tunnel-boring machine (TBM) launch is expected to be in the second quarter of 2012. TBMs are not now manufactured in the UK, so will have to be imported. Seven TBMs will be required, to bore 21 km of twin-bore tunnel in ten drives. The first two machines will tunnel their way from Royal Oak (west of Paddington) to Farringdon. Two more will, later in 2012, commence from Docklands to Farringdon. There will be shorter tunnels in the Royal Docks area and east London. All running tunnels are to be of six metres diameter.

Station tunnels are of course to be wider, to accommodate platforms. It appears that some contractors will probably sink shafts and excavate station tunnels (platform tunnels and connecting tunnels and shafts for escalators and the like) first (the top-down method) before the running tunnels reach the station sites.

Others may opt for the 'bottom-up' approach, excavating the station tunnels from the completed running tunnels, which would avoid having to remove excavated spoil from station sites and through the central London streets. Alongside an interchange at Farringdon, new subsurface stations (with links to the Underground) are envisaged at Bond Street, Tottenham Court Road, Liverpool Street and Whitechapel.

SOURCE: HARVEY, Dan, 2011. Crossrail update: gearing up for tunnelling. *Modern Railways* 68(749), page 98.

Train derailed by ice in Summit Tunnel

A Trans-Pennine Express train from Manchester Airport to York was derailed in the Summit Tunnel at the inconvenient time of 0119hrs on 28 December 2010, about 740 metres in from the north portal, south of Todmorden. The 45 passengers and train staff were unharmed, and led out of the tunnel by 0440hrs.

The 2885-yard-long tunnel, between Littleborough and Walsden stations, was built in 1837–1840, and has a number of open spoil-extraction / ventilation shafts. It made national headlines in the early 1980s when an oil tanker train caught fire in it: newspapers carried photographs of flames shooting out of one or more of the shafts from the conflagration below. The tunnel was repaired, and reopened in 1985.

In the December 2010 incident it was a case of the shafts being too cold, rather than too hot. The train, travelling at the time at about 70 mph, was derailed by a block of ice,

reportedly measuring two metres by eight metres, which had formed in and fallen down shaft 10.

Passengers were further alarmed by the sound of more ice falling onto the train roof, perhaps suggesting to some that the entire tunnel was about to cave in! More ice was subsequently found to have fallen down shaft 11.

SOURCE: ANON, 2011. Tunnel ice-fall derails train. *Modern Railways* 68(749), page 7.

Road collapse resulting from tunnelling at Belfast, Northern Ireland

One of the busiest roads in Belfast has collapsed, apparently as a result of tunnelling a year previously. Northern Ireland Water has accepted responsibility for a 15-square-metre hole in Cromac Street. Fifteen metres below, a four-metre diameter sewer had been driven a year before, as a flood alleviation measure.

The new sewer, 9.5 kilometres long, had been driven using an earth pressure balance tunnel-boring machine. Such machines retain excavated spoil behind the cutting heads to assist in the support of the not-yet-lined tunnel. It is claimed that the ground did not collapse into the tunnel, but that the tunnel disturbed and reactivated a pre-existing cavity.

SOURCE: GOLDFINGLE, Gemma, 2009. Belfast road collapses above void triggered by tunnelling. *New Civil Engineer*, 12 November 2009, page 7.

Gotthard Base Tunnel breakthrough, Switzerland

The Gotthard pass through the Swiss Alps has been a well-used road between Switzerland and Italy at least since the thirteenth century, lying on the route from Zurich to Milan. Although Switzerland's railway system (designed initially by our very own Robert Stephenson) developed throughout the more low-lying country from 1844 onwards, a railway through to Italy via what was to become the first Gotthard tunnel was planned only from 1869 onwards.

The single-bore double-track Gotthard tunnel (15 km) was opened for steam-hauled trains in 1882, between Flüelen and Biasca, with a summit height of 1,162 metres above sea level. It was electrified in 1921. It lies entirely within Switzerland, although southbound travellers passing through Bellinzona sometimes imagine they have already crossed the international border!

In 1980 a motorway was opened on this international route, with its own 17-km road tunnel. This, however, was closed for two months in 2001 as a result of a disastrous fire in the tunnel. That event, and the Mont Blanc road tunnel fire, caused a revaluation of road tunnel fire risks throughout Europe, and much expensive re-engineering to make them safer.

As the Gotthard route is of prime importance, linking countries north of Switzerland with Italy, the existing rail route is now used to capacity (150 freight trains per day), and increased motorway construction and use is seen as environmentally damaging (for a country heavily dependent on tourism).

A railway short-cut via the Gotthard Base Tunnel, approved by a referendum in 1998, has been under construction since 2003, and was holed-through on 15 October 2010. This (and two additional long tunnels, one each in Switzerland and Italy) allows a more direct route from Zurich to Milan (saving 40 kilometres by rail) at a lower summit level (600 metres below the old tunnel) and on much easier gradients.

The total of three new long tunnels will save an hour off passenger trains between the two cities. Completion and fitting-out of the new Base Tunnel is expected to be complete and trains should be running in 2017.

SOURCE: MALINS, Richard, 2010. Crossing the Alps. *Modern Railways* 67(747), 78 – 81.

Smuggling tunnel, Mexico to California

A smuggling tunnel six hundred yards long has been discovered under the California – Mexico border, near Tijuana (Mexico). With entrances each end inside warehouses, the tunnel had been equipped with lighting, ventilation, and a rudimentary railway. Authorities seized twenty tons of marijuana at the US end, and another four tons were impounded by their opposite numbers in Mexico.

SOURCE: WATSON, Julie, 2010. Marijuana mountain found inside rail tunnel built by Mexico cartels. *Evening Standard*, 4 November 2010, page 27.

Subterranea Britannica Autumn Meeting

Saturday 15th October 2011

Please make sure you have the date in your diaries now.
The location will be in London.

Dr David Walker speaking about the Nottingham Caves Survey

Peter Kendall, English Heritage (Inspector of Ancient Monuments for Kent) speaking about below ground aspects of the Chatham forts

Mike Barton concluding his talk on BRIXMIS and the Cold War missions

Further details of the Programme and Speakers will be published in the next issue of *Subterranea* and will be on the website www.subbrit.org.uk or email info@subbrit.org.uk

NZ Coal Mine Blast Kills 29 Miners

by Roger Gosling

This article (without the 30 March 2011 update) first appeared in the Shropshire Caving and Mining Society magazine and also the South Gloucestershire Mines Research Group newsletter, and is published again here, with permission, for the benefit of SB members.

Since the last SGMRG newsletter, you can't have escaped the news coverage of the successful rescue of 33 miners trapped by a collapse in the San Jose copper mine in Chile. This was described as a 69-day shift from hell. The rescue plans put into place were successful and all 33 were rescued alive, watched by the world's media.

Not so lucky were 29 miners in the Pike River coal mine, near Greymouth, on the northwest coast of South Island, New Zealand. The trapped miners ranged in age from 62 down to a 17-year-old on his first shift underground. On Friday 19 November 2010 there was an explosion underground and shortly afterwards two survivors emerged from the mine. At that time there was hope that the other 29 miners may have somehow survived. We now know that was not the case. Two of the miners killed were from Scotland: Peter Rodger, 40, from Perth, and Malcolm Campbell, 25, from St Andrews.

Daniel Rockhouse, one of only two survivors, was blown off a loader when hit by the blast. It is believed that he was working in a side tunnel off the main access route and this shielded him from the full force of the blast. Russell Smith, a coal cutter, had been late for work and was driving into the mine; he was found semi-conscious about 15 m from his vehicle by Daniel and the two then took at least an hour to make their way out of the mine along the dust-choked tunnel. Contact with the 29 miners could not be made using a phone line deep into the mine.

Russell Smith told New Zealand's TV3 news that he was driving a loader into the mine when he saw a flash in front of him. "It wasn't just a bang, finish – it just kept coming, kept coming, kept coming, so I crouched down as low as I could in the seat and tried to get behind this metal door, to stop getting pelted with all this debris.

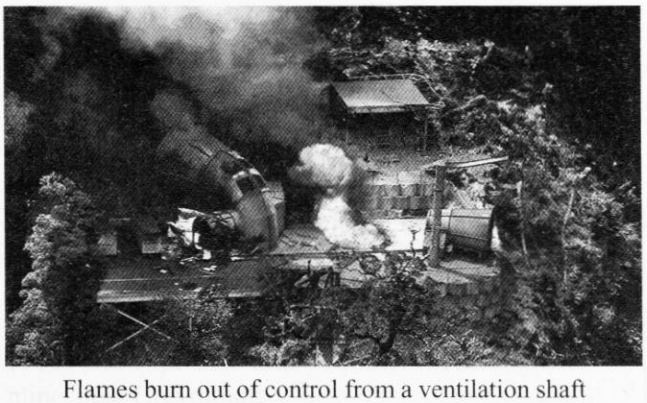
"I remember struggling for breath. I thought at the time it was gas, but it was dust, stone dust. I just couldn't breathe. And that's the last I remember," he said. "I could easily have been blown to bits. Because I wasn't as far up [the access passage goes uphill towards the workings], the explosion wasn't as bad for me. It knocked me off my feet and knocked me unconscious and someone dragged me the 300 metres, brought me round, and then the two of us held each other to get out of the mine. The blast was not just one bang, but kept coming."

The fact that the mine had 'gas problems' in it was well known before the blast (in fact there was a report of this from the shift before the explosion), and modern ventilation systems are in the mine to control this. However for some reason, yet to be ascertained by a Coroner's Inquiry, a Department of Labour Inquiry and an NZ government Royal Commission of Inquiry, a considerable quantity of inflammable gas exploded.

A further blast five days later on Wednesday 24 November effectively signalled the fact that it was very unlikely that any miners would be found alive. What has not made headline news is that at the time of writing this (30 November) there have been a further two explosions after this. The fourth explosion was more violent than the second and third. Also today a "pillar of flame" shot through a mine ventilation shaft.

"The smoke has changed – it's no longer a gas fire, it's obviously now a coal fire," said the Pike River Mine Chief Executive, Peter Whittall. "Where that coal fire is or how big it is, we don't know."

It is likely that a fire caused by one of the explosions has spread to the coal seam and has caused some of the mine workings to collapse. Earlier attempts to seal the mine and starve it of oxygen by the use of expanding foam were unsuccessful as the foam had also caught light.



Flames burn out of control from a ventilation shaft

Peter Whittall had remained hopeful that crews would be able to recover the bodies of the men, but he has admitted the recovery hopes had diminished. He said the bodies could be up to 500m from the main fire, but he had no idea what condition they would be in. Some families had begun accepting "total loss of life" and that the bodies of their loved ones would not be recovered. NZ Prime Minister John Key has spoken to the grieving families and pledged government support for them. He said the commission of inquiry would leave "no stone unturned" in trying to find what caused the explosions.

"The safety of the people involved in the recovery remains a priority and this will continue to be a priority through the entire operation. The recovery phase will continue to involve a team of specialists with a wide range of expertise."

*The **GAG** is a "jet engine inertisation unit" developed for use in mines, controlling and suppressing coal seam fires and neutralizing firedamp. The unit was designed in Poland in the 1970s, and roughly translates as "Mining Apparatus Extinguisher". A GAG 3A unit was developed by the Queensland Mines Rescue Service, in association with the Commonwealth Scientific and Industrial Research Organization (CSIRO). The GAG unit emits carbon dioxide, nitrogen and water vapour. The gases lower the oxygen levels, suppressing fires, and forcing methane out of the mine. A unit is capable of pumping a volume of 25 m^3/s, creating levels of less than 1% oxygen. When fully assembled, the unit is 12 metres long and weighs 2.5 tonnes.*

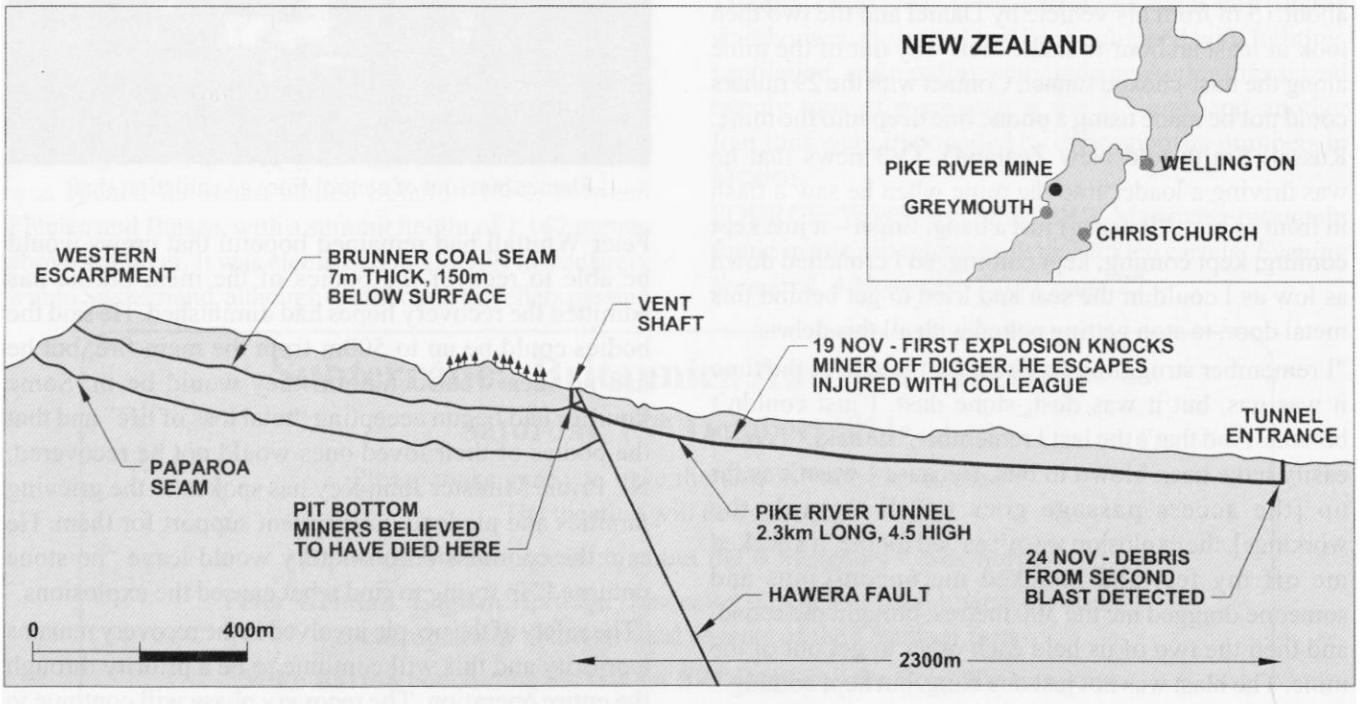
Currently there are only three GAG units in the world – in Holland, the Ukraine and the one currently on loan to Pike River Mine. GAG units have been used most notably in 2000 at the Blair Athol Mine, Queensland, where it extinguished a 54-year old coal fire. In 2003, a team from the Queensland Mines Rescue Service took a unit to West Virginia, where they successfully extinguished a 660-ft deep, two-month-old fire at Loveridge Mine, after ten days of continuous use. So there is definite hope that this plan will work at Pike River.

The current plan to control the fire(s) is to use a machine known as the Gorniczy Agregat Gasniczy (GAG) unit. This has been flown to the mine from Queensland, Australia and is to be used to pump inert gases into the mine.

Initially it seemed that immediate rescue attempts were inadequate, due to extreme caution about poisonous and inflammable gases. Control of the rescue attempts was in the hands of the NZ Police and other Government agencies – a completely different strategy from the more normal "Mines Rescue" services around the world.

The miners were assigned to an area at the far end of the workings. On 23 November a hole drilled into the area near where the miners were working encountered potentially deadly gases. Hot air and gas rushed through the hole when the chamber roof was punctured and initial tests showed it was "extremely high in carbon monoxide, very high in methane and fairly low in oxygen". It was very likely that the initial explosion was caused by ignition of a high concentration of methane.

The mine is a relatively new venture, production of coal only starting as recently as 2008. It is New Zealand's largest coal mine and employs some 150 people (NZ has four currently working coal mines employing a total of about 450). The mine accesses the Brunner coal seam 7m thick about 150 m below the surface, and the Paparoa coal seams below. The access tunnel to the main workings is 2.5km long under the Paparoa (mountain) Ranges; the Hawera fault, through which methane gas is known to escape, is between the entrance and the working area.



THE PIKE RIVER MINE

Drawn by Tim Robinson

The Pike River Mine company remains hopeful that the mine will be able to resume production of coal in the future. Peter Whittall said, "As a mining engineer, a mining manager, I would definitely expect that to be the case. If the roadways are open there is still 50 million tons of coal there. The roadways are probably in good condition although there has been a lot of damage to a lot of equipment. But at this stage it is just not what we are focusing on." The board of Pike River Mine has been meeting to discuss its options for the future in the aftermath of the explosions.

Gerry Morris, a mining expert, said yesterday it was hard to accept that Pike River Coal had overlooked the ventilation of dangerous gases "with the money they have spent developing that mine". He accused Pike River Coal of failing to disclose enough useful information for the area's miners "to make their own conclusions".

The geology of the Paparoa Ranges was notorious. Pike River is just 20km from the Brunner mine, where 65 died in 1896, and had the same gas issues, which the company was well aware of and had highlighted to investors in the week before the explosion. Mr Morris said it probably only needed a cubic metre of methane and a spark to go off to have a devastating effect.

New Zealand Mines Minister Gerry Brownlee has promised action over how the industry was regulated following the two explosions at Pike River. The government and Pike River Coal had come under criticism before the catastrophic second blast. Concerns had been expressed about the known high levels of methane generated by the rich coal seams in the mine. There have also been criticisms that the range of survival equipment within the mine – it had no security cages and no stores of food, fresh water, long-acting self-breathers or emergency lighting – was below the standards of Australian coal mines. There is only one entrance to the mine. Some local and Australian observers have criticized the fact that, unlike in Australia, where mining companies were in primary charge of dealing with a mine crisis, in New Zealand the rescue operation was put in the hands of the top police officers in the region.

The Australian general secretary of the mining and energy division of the Construction Forestry Mining and Energy Union, Andrew Vickers, was quoted on New Zealand television saying the mining company, in consultation with the unions, should have been in charge. "They are the only people who know the mine; they are the people with the technical expertise," Mr Vickers said.

Lawrie Drew, whose son Zen was one of the miners killed and who has served as an unofficial spokesman for the families, speaking of a "cover-up" said, "That mine should never have been opened in the first place. A lot of people do not understand why the police were in control in the beginning."

He also said miners' families were angry that rescuers had not entered the mine after the first blast. "They had their window of opportunity that Friday night, and now the truth can't come out because no one alive will be able to come out and tell the truth about what went on down there."

The Pike River mine was known to have a high generation of methane. In 2007, Western Exploration geologist Murry Cave said in a report there were a number of risks in the underground site, including a pit bottom with deep, highly gassy coal and the associated risk of "outburst". The company has consistently denied that the mine was dangerous, saying gas was present in all coal mines but the ventilation systems were coping with it. Pike River Coal chief executive Peter Whittall admitted earlier this week that, by definition, the mine was unsafe at the time of the first explosion.

Pike River Coal has donated NZ$500,000 (£250,000) to a charitable trust set up for the families of the 29 miners killed in the explosions. The contribution has been matched by major shareholder New Zealand Oil and Gas, and other companies that work with Pike River have also pledged support. Chairman of Pike River John Dow said the trust would help pay for support and other services for the victims' families. Four trustees will manage the fund, chosen by the Mayor of Greymouth, Pike River coal mine and the families, with at least one nominee having disaster relief expertise.

New Zealand mine disasters

1879: Probable gas explosion kills 34 men and boys at Kaitangata mine

1896: Suspected gas explosion kills 65 men at Brunner mine, near Greymouth

1914: Gas explosion kills 43 men at Ralph's mine in Huntly

1926: Explosion kills nine men at Dobson mine, near Greymouth

1939: Carbon monoxide asphyxiates 11 men at Glen Afton mine in Huntly

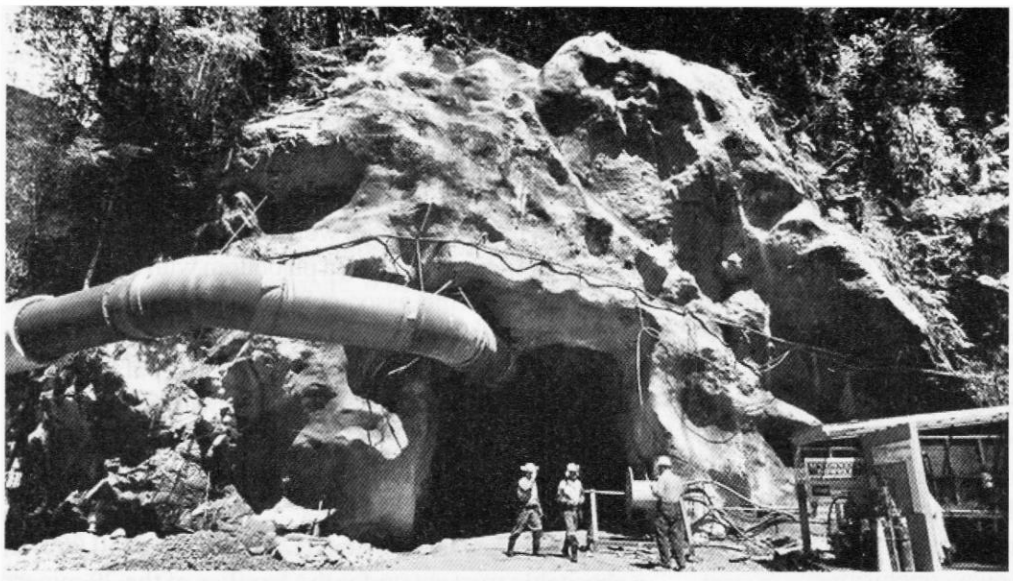
1967: Gas explosion kills 19 miners at Strongman mine, near Greymouth

2010: Explosions at Pike River mine, near Greymouth, are believed to have killed 29 miners

Note previous accidents at other Greymouth mines.

This report has been compiled by Roger Gosling from various sources on the internet. I have resisted the temptation to write my own opinions and the information is based on the writings of experts and newspaper reporters. Prime sources of information were:

www.pike.co.nz
www.nzherald.co.nz
www.miningaustralia.com.au
www.theaustralian.com.au
www.dailytelegraph.com.au
www.telegraph.co.uk
www.bbc.co.uk



Entrance to the Pike River mine

ANALYSIS

What went wrong at Pike River mine?

by Andrew Watson, Commercial Manager for the UK Mines Rescue Service

Following the very, very tragic accident in New Zealand, there will be the obvious comparisons between the events in Chile and New Zealand. But really, there is no comparison. Chile was a hard-rock mine where the hazards are man-made. These can be controlled by ensuring high standards are adhered to and good planning. With coal mining, there are additional hazards that occur naturally, such as methane, spontaneous combustion (fire), carbon monoxide and hydrogen sulphide and, because it is a soft-rock mine, the strata around the coal needs to be supported.

All of these are controllable by high standards, regulation and good management. But what could have gone wrong? The initial explosion last Friday was a methane gas explosion, but the ventilation shaft should have ensured that methane did not build up to dangerous levels.

After explosion: Methane gas is explosive in atmospheric ratios between 5% and 15%. In coal mines in the UK, we aim for less than 1% methane. At 1.25%, the power automatically cuts off, and at 2%, all miners are evacuated. At Pike River, the fact that there was an explosion suggests the methane reached 5% or more. So, either the warning system was inadequate, or it was not sufficiently monitored.

Once the initial explosion occurred, the following would have been lost:

- Communication
- Monitoring of the mine atmosphere
- Ventilation

In such cases, it means that rescuers don't have much information to work with. In the case of Pike River, what they would have done immediately is have gone to the return ventilation side of the mine and taken samples. That would have told them how much methane, carbon monoxide and hydrogen was in the atmosphere at that point. What it would not have told them was what the conditions deep inside the mine were – which parts were safe and which weren't. The explosion might have damaged ventilation equipment such as fans, ventilation doors and seals. It might also have caused rock falls.

The miners would have been trained in these situations to travel towards a safe haven. If this couldn't be reached, the hope is that they would have barricaded themselves in somewhere away from this toxic and noxious environment.

Rescue decision: At this point, the rescuers would have had to decide whether it was safe enough to deploy a rescue team into the mine to gain the information they desperately needed. This did not happen at Pike River, so clearly the information obtained from the return side samples indicated that it was too dangerous to enter the mine. Some people have accused rescuers of being too cautious, questioning whether a window of opportunity had been missed. They insist that emergency teams should have been sent into the Pike River mine soon after the initial explosion.

The team would have had access to breathing apparatus – what we call long-duration sets. These weigh 17kg (37lb) and last up to four hours. But when you consider the distance that rescue team would have to travel, it is clear that the apparatus would have been right on the limit. It was almost 1,200m (3,940ft) to the first cross cut, and 2,300m (7,545ft) to the end of the tunnel. Double that distance – to get in and back out – and you are taking things to the extreme. Now consider the conditions in the tunnel. It would be very, very hot – because the ventilation may well have gone. And, because of the rock fall, the terrain would be rough.

Too dangerous: This could have been challenging even for a fit team of rescuers. So, instead of going into the mine to get this information, they drilled a 162m (530ft) bore hole from the surface, which obviously took time. Once completed, it verified that the atmosphere inside the mine was too dangerous to enter with dangerous levels of methane and carbon dioxide, so the worst scenario for the miners had been realised.

From a rescuer's point of view, this is as frustrating and distressing as it can be. These men would have been

trained to help and rescue their colleagues. It is in the nature of miners to work as a team and to help each other in this extreme environment, and that is what the rescuers would have wanted to do. There is absolutely no doubt that, if it had been possible for them to enter the mine at any time, they would have done so. These men would have been aware that the environmental readings were preventing this.

No doubt, in the days and weeks to come there will be much discussion about what lessons can be learned from this disaster. Of fundamental importance is the need to maintain high standards. Mining safety standards in New Zealand are very similar to those in the UK. But, at Pike River, something went badly wrong, leaving many questions unanswered.

PIKE RIVER MINE DISASTER – UPDATE 30 MARCH 2011

Since writing the article (in early December) on the Pike River Mine Disaster, there have been some developments.

The main highlights are that the fire was eventually put out by using the GAG unit on loan from Australia. However several hot-spots were thought to remain in the mine and the atmosphere inside was not safe for people to enter. Greymouth District Mayor Tony Kokshoorn has written to the Pike River receivers asking them to consider raising money from shareholders for a rescue operation to recover the lost miners' bodies. He said it was common knowledge that the atmosphere in the mine was now inert and, while there were concerns about its structure, he believed the real problem was who would pay for the recovery.

There have been several attempts at sending in robots to check the condition of the bodies in there, but as yet none of the robots has made it far enough in. There is considerable pressure from relatives of the dead miners on the mine company to recover the bodies. On 18 February, New Zealand's Prime Minister John Key said the Pike River coal mine where 29 men died in November will be sealed.

Key defended a decision by the police to abandon efforts to recover the bodies of the men. He said it was a very tragic end for the families but recovering the bodies is just not possible. He said the mine would be sealed and there was no chance of recovering the remains of the miners. However it seems that recovery attempts will continue; the most recent attempt was to have been in the last few days (25 February), but as a result of the more recent earthquakes in Christchurch, the robot has been sent to help in the rescue efforts there instead.

As a result of the cessation of mining and the cost of the disaster, Pike River Mine Company has become bankrupt and management of the site is now in the hands of the mine's receiver Price Waterhouse Coopers. The receivers say unsecured creditors owed more than NZ$31 million (including NZ$15 million to tradesmen and almost NZ$3 million to employees) are "unlikely" to be paid. The company was placed in voluntary receivership by its board in December, just weeks after 29 men died in the explosion.

However there have been over a dozen unsolicited expressions of interest in the mine, most from overseas. NZ state-owned Solid Energy, which has 110 years' experience of mining on the coast, says it is the only coal mining company in the world capable of successfully mining the Pike River coal seam. This, the company proposes, would be by a "long-term integration" of open-cast and underground mining. It is indicating that if it does buy the assets, it will try to recover the bodies of the 29 men who died in the mine.

The official NZ government Royal Commission inquiry into the Pike River mine tragedy has started; it is intended to hold 15 weeks of hearings, beginning on 6 May 2011 and finishing in November.

The hearings will be organised into four phases:

- Phase 1 will examine New Zealand's regulatory environment and the geography, approval and development of the mine.
- Phase 2 will explore the search and rescue operation at the mine, and the cause of the deaths.
- Phase 3 will examine the cause of the explosions and Pike River Coal's operational and management practices.
- Phase 4 will focus on the policies that govern mining.

The inquiry will seek to establish what happened at the mine and to identify how to prevent mining tragedies. Pike River family spokesman Bernie Monk said the reason for the deaths could not be fully answered until the mine is re-entered.

In the wake of the disaster, some vocal critics have argued that health and safety standards in some New Zealand mines had been eroded. A 2008 government review raised serious questions about the industry and called for renewed safety measures, including the return of the check inspectors, additional to the Government's mine inspectorate. That report argued that the elimination of the worker-elected check inspectors potentially left miners open to commercial pressures and day-to-day work-site management decisions.

There will certainly be ramifications to come from the Royal Commission and it will be interesting to see how long it is before the bodies are recovered. As mentioned above, it is also possible that one day coal mining will resume at the mine – we will see.

Since the explosion at Pike River, there has been an explosion at the La Preciosa coal mine in Colombia, about 400km northeast of the capital Bogotá, on 26 January 2011, killing 21 miners in another methane explosion.

Cults Limestone Mines: Exploring the thousand-year-old limestone mines in the Howe of Fife

by Mark Chalmers

In amongst the overgrown hummocks of spoil that line the Cults Ridge, there was little sign of the old limestone mines – only a tell-tale draught of air breathing out of an overgrown adit. Yet there we were soon after, standing in the umbral silence: we had dropped from the rolling farmland of Stratheden into the deafening quiet of a labyrinth. Outside, a light breeze was fidgeting with the leafless branches of the beech trees, and blackbirds were rustling in the frozen leaf litter.

A generation ago, Fife was a mining kingdom; the Michael Colliery was one of Europe's largest, employing 3,500 men at its peak, and two 'superpits' were built by the NCB, at Seafield and Rothes, both of which fell prey to difficult geology.[1] The lime industry operated in coal's shadow, yet whilst almost all traces of coal mining in Fife have been cleared, something remains of the lime industry, if you know where to look.

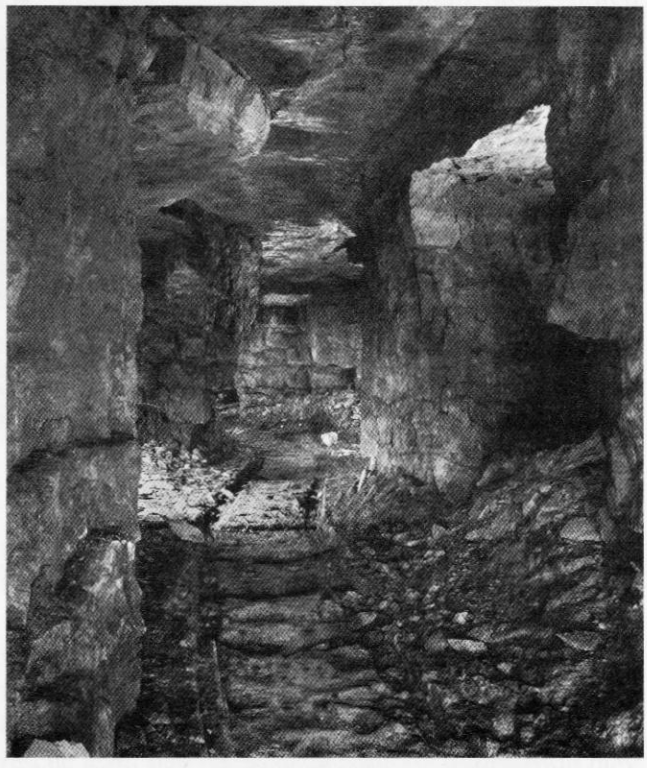
On the banks of the Firth of Forth stand the Charlestown mines, and a few miles to the north lies the Cults Ridge. The mines at Cults produced some of the purest lime in Scotland, and were large enough to warrant their own internal tramway system, yet very little has been written about them. However, the research carried out by Gavin Saxby, Richard Black and I over the past couple of years has gradually revealed the full extent of the mine's history.

Early Workings

The Cults Ridge is part of the Charlestown Main Limestone in the Hurlet formation, and the high purity of the limestone was well-known to its early inhabitants. The first Cults mines date from medieval times, when farmers began delving in the hillside for limestone: the stone was crushed then burnt in clamp kilns to make quicklime which, once slaked, was spread on the fertile soils of Stratheden. In old Scots, the area was called Quhilts, and there is evidence of a community from at least 1243, when a kirk was founded here.[2]

The earliest surviving workings at Cults are pillar and stall, and when Thomas Cochrane took over the mines in 1926, he noted that the Cults of Pitlessie limeworks, as he called it, had been going on for many hundreds of years.[3] In fact it was known that lime was mined here from the eleventh century making Cults one of the oldest continuously-operated mines in Europe, until its closure in the 1980s.[4] The old tower of St Regulus in St Andrews was built using Cults lime sometime around 1060, as were the dungeons under the town's castle. Centuries later, the enormous beet silo of the British Sugar Corporation's works at Cupar was also built incorporating Cults lime in the concrete.

By 1685, the Cults limestone was being burnt using locally-mined coal and oil shale to produce good-quality lime for the building industry, and for agriculture.[5] In that year, James Jaffrey of Kirkton of Cults was operating the mine, and sold whitening lime plus stone to Dr Alexander Skene, who was Provost of St Andrews University. At that time, the mine was shallow and the shot holes were hand-bored, the stone being blasted then wheeled to the surface in hand barrows, from which it was shovelled into clamp kilns. The main market was burnt lime for masonry mortar, with the remainder going as agricultural lime.[6]

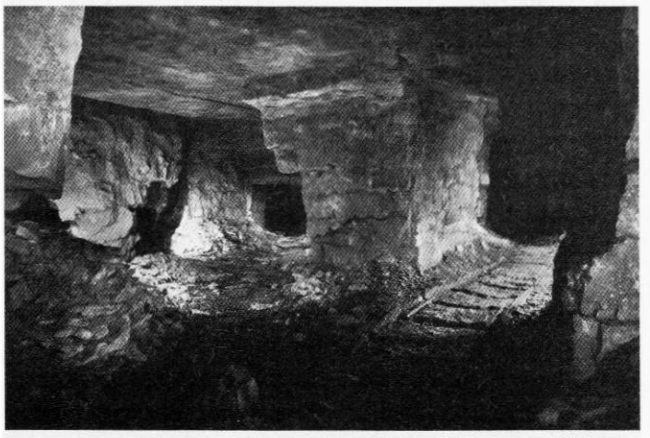


Outline of narrow-gauge trackbed in an older part of Cults mine: before the introduction of tractors as motive power, most limestone skips were propelled by hand along winding passages with minimal clearance. This shallow drive meanders for almost a kilometre

By the early 1800s Cults consisted of two mines and two sets of lime kilns, the East Works beside Cults crossroads, and the West Works which lies half a mile along the road. The draw kilns were built at the East Works in 1809, and still stand despite being derelict – a series of far older clamp kilns line the roadside between the two works.[5]

Abandonment plans for the older parts of the Cults mine, and the newer Skelpie mine, reveal over twenty miles of passages; many now lost to 'untopping', a rising water table, and collapsing inclines. Stone mines are often casually referred to as "labyrinthine", but Cults really does earn this description, because the older workings lack any sense of order and were driven to follow local geological trends, rather than an over-arching development plan. The seam dips southwards at roughly 6-7 degrees, following the sedimentary limestone band,

and the mine drained to the south, following the Hurlet Limestone. Latterly, the southern ends of the drives acted as sumps, from which the mine was drained. Anecdotally, there is or was a drainage adit which also allowed workers who lived on the southern side of the Cults Ridge to walk through on their way to work.[7]



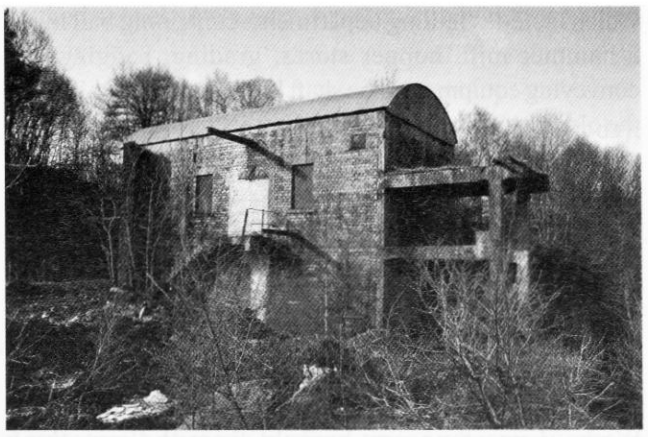
Outline of narrow-gauge trackbed in an older part of Cults mine: the tracks have been lifted in more accessible parts of the mine, but elsewhere it's possible to make out a mixture of timber and pressed steel sleepers, carrying lightweight iron rails

Mechanisation

By the mid-19th century, a network of narrow-gauge tramways which connected to the Cults & Pitlessie branch line was key to the operation of the mine and limeworks. The branch line was built in 1876, and at that time the limestone mines, quarries, and works were all owned by the Earl of Glasgow, who owned the Crawford Estate on which they lay, and who leased them to James Martin of Priestfield. In 1886, the estate became bankrupt, but was rescued by the Cochranes, who had married into the Earl of Glasgow's family. At the same time, a new fifteen-year lease was granted to James Martin for Cults limeworks and mine, which included the railway. Martin set about working the limestone in a systematic way: at the western end, the Dodsfield limestone working was stopped in December 1887 when the edge of good stone was reached.

Cults Mine itself stretched westwards in the early years of the twentieth century, but stopped in 1911 once it reached the limit of the Charlestown Main formation. Martin then drove parallel drifts southwards.[8] The mines were later run by his son William Martin and by 1918, had passed to his grandson, another James Martin, but at the end of the Great War, the Martins felt they couldn't continue with their lease, due to old age and ill health, so it reverted to Thomas Cochrane, as landlord.[5]

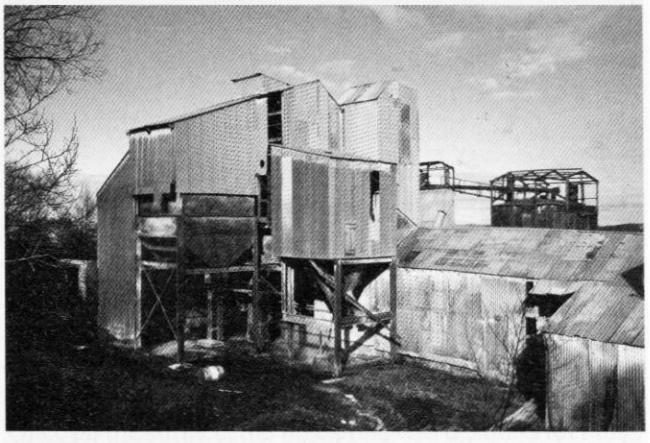
Thomas Cochrane, the 1st Baron of Cults, decided to invest in Cults Lime Co. by providing a Foden steam lorry to transport coal from the Rameldry coalmine.[3] James Martin had also operated the Rameldry coalmine, a few miles away at Kingskettle: the Rameldry coalfield was an isolated tract of coal-bearing strata, which was worked from at least 1873 until the early 1930s. It



Head house on incline from main adit of old mine at Cults East Works: this concrete-framed winding house, with walls built up in panels of common brickwork, housed the electrically-powered winder drum which pulled skip frames up the main incline then emptied them into a "tippler" mechanism which sat on the reinforced concrete beams.

produced anthracite-like "manufacturing coal", which was mainly used to feed Cults Lime's limekilns.[9]

In September 1929, Lady Cochrane opened a major extension to the East Works; two new gas-fired shaft kilns were built by Priest Furnaces of Middlesbrough, which cost £17,250.[5] Contemporary photos show enormous structures over eight storeys high, fed by conveyors from a rake of railway sidings. At the same time, pusher-leg compressed-air drilling was introduced to Cults, along with mechanical loading. A producer gas plant was built on the site to fuel the kilns[6], and one of the surface buildings was adapted as an air compressor house.



Limestone mill building at Cults East Works: completed in 1928 to house a pair of ball mills, this steel-framed building was connected by conveyor to the gas-fired kilns erected by Priest Furnaces of Middlesbrough.The remains of the kiln-charging hoppers sit in the background

1929 Lime Works

The 1929 lime works consist of a limestone hopper building built of brick and concrete with a corrugated iron roof, the hoppers being fed using a tramway overbridge which crossed the road from the mine. From the hoppers, the limestone passed into the main limeworks,

which includes milling departments containing ball mills, a hammer mill, hopper stores, grading, bagging and conveying equipment. The shaft kilns were built to replace the old East Kiln, and sit within a steel frame with rivetted steel cladding – they were fed by conveyor from a crusher, which was the next stage after milling. Finally was the finished lime store – a former aircraft hangar re-erected here by prisoners-of-war.

The triple-pot limekiln at the West Works dates from 1870, and was rebuilt in 1937 using reinforced concrete – branded "C of C" to represent Cochrane of Cults – to supplement production from the gas-fired kilns at the East Works. Limestone was brought from the mine by a narrow-gauge railway, then layers of crushed limestone were tipped into the top of the kiln, alternating with layers of coke. The high temperature in the kiln (1,000 degrees Celsius) turned the limestone into quicklime, which was drawn out from the "eye" of the kiln, reached through the front arch. Four hundredweight (cwt) (200kg) of coke plus 1 ton (1,000kg) of limestone produced thirteen cwt (650kg) of quicklime. Each chamber could produce around 200 tons of quicklime per month, some of which went to agriculture, though a lot more fed the brickworks.

Hudson 2ft gauge ore skip frame: several of these skips have been abandoned close to the haulage inclines, many more were left on the surface when the mine closed, but have since been scrapped

The plans indicate that the oldest section of the mine lies opposite the West Works, and the workings close to the surface show little sense of order, with irregular rows of pillars and curving drives departing from the grid in search of good stone. It's evident that a wagonway ran laterally through the mine, with grooves cut into the stone floor for the hutches (tubs) to run on. The haulage inclines in this part of the mine still have some light rails (25 or 30lb/ft) in place, and the rusting remains of haulage cables, track switches, plus a (submerged) incline drum are still visible, along with a couple of Hudson-type ore hutches lying in side galleries.

20th-century Expansion

The main haulage from the mine, with an adit directly opposite the East Works, was rebuilt in the 1940s, with some roads brick-lined to carry a steel girder roof. Since closure, the shifting geology has caused much of the roof to distort and buckle. The mine's main haulage was up an incline of approx 1:15, which continued rising outside the adit, running onto an embankment then across the road on a steel overbridge into a head-house with an incline winder, and hoppers above the crushers. [10] Parallel to this rebuilt haulage was an older incline, which is in poor condition – but a large-diameter cast-iron pipe suggests this may have been a pumping main carrying the drainage from that district's sump.

Main haulage adit of old mine at Cults: this incline was rebuilt between the wars, with an engineering brick lining and new roof of rolled steel beams. The 2ft gauge tracks ran up through the portal onto an embankment which crossed the main road on an overbridge, then ran into the head house

From the 1930s, the main thrust of exploration was eastwards towards the Cults crossroads then beyond, towards Skelpie during the 1950s – and for a brief period in 1963/ 64, southwards – passing through "troubled ground" deep under Upper Bunzion Farm. The deeper drifts were prone to flooding, so during the 1950s this southern outlier had several local pumps running: a 28hp Drysdale pumping 120 gallons per minute (gpm); a 12hp Mono pumping 40 gpm; and a 4.5hp "Goodenough" pump lifting 20 gpm – all of which ran 24 hours a day. [8]

100 metres down the main haulage adit of the old mine at Cults: once pumping stopped, the mine quickly fell prey to the seasonal variations of the water table. You can see that the steel beam's web has corroded through completely, and barely holds the two flanges together

By 1966, an average of 30,000 tons of finished lime was produced each year by a workforce of over 70 – although peak production exceeded 72,000 tons.[5] There's anecdotal evidence that modern drum calcining kilns were added in 1950, but this is difficult to prove due to the demolitions which have taken place on the surface.

The Cochranes made a presentation to the McKenzie brothers of Pitlessie in 1967 – between them, the four brothers had given 250 years of service to Cults Lime Ltd.[6] In the manner of so many long-standing Scots businesses, entire families were happy to spend their working lives – often from the age of fourteen until they reached their seventies – in the same employment. Their loyalty was rewarded with true "jobs for life", and often the employers felt a patriarchal responsibility towards them, particularly in dangerous occupations like mining.

In 1968, Andrew Faichney took overall charge of Cults, and a year after that, the *Fife Herald*'s reporter spent "a Day Among the Miners of the Cults Lime Hills". [4] Faichney was the Managing Director; John McNeil was in charge of the surface works, as Cults Limeworks manager; and Tom McKenzie was one of the underground mine managers. The men worked from 7am to 3pm, with seven employed underground in 1969, as opposed to 32 men in 1950.

The access adit was electrically-lit, and ventilated by Davidson of Belfast's "Sirocco" fans in new fan houses built on the surface earlier in the 1960s; a traffic-light system was used in the main incline to prevent collisions between the underground vehicles. The newspaper reporter also commented on the existence of "escape tunnels" at Cults – presumably some of the labyrinth of earlier tunnels had been adopted in the mine's rescue plan. Cults shared cover from the Mines Rescue Station at Crossgates in Fife with the remaining deep coalmines of the Fife Coalfield.

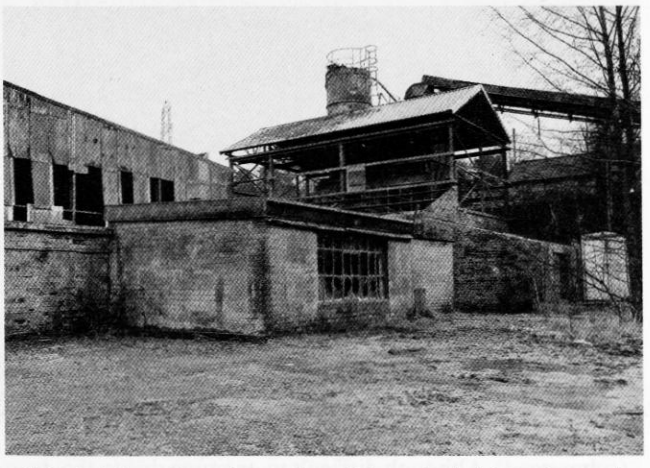
The working of the faces at Cults is described in some detail, with Atlas Copco compressed air drills in use, which advanced at a rate of twelve inches per minute. The shot holes were drilled four feet deep, and charged with Nobel's gelignite, individual charges being connected by a "strum" of detonation cord. Blasting took place at 3pm each day, once the mine was clear of miners, and each blast brought down 40-50 tons of limestone – leaving the dust to settle overnight. An Eimco rocker shovel was used to load stone into a trailer, which the tractor and bogie pulled to the surface up the incline.[4]

Haulage was by tractor and trailer, with three pairs of Massey Ferguson tractor plus bogie combinations generally in use: each could take a load of five tons. Free-steered vehicles (FSVs) were considered for underground haulage but it was felt that the remaining lifespan of the mine didn't justify the investment required, especially given the tight clearances in older parts of the complex. "The stone was blasted, then shovelled by a pneumatic tracked shovel onto a farm-type trailer which was hauled by tractor."[7]

Recollections

As one former employee said of Cults as it stands today, "I worked at Cults one summer when I was a student, in 1977. It's sad to see it dead – they were a decent bunch of people, though I suspect most of them are now dead, too. The workings extended in the limestone seam all the way through the ridge – I was told of one guy who used to walk to work through the hill ... In 1977, it was definitely a drift mine, with forced ventilation. Transport was all rubber-tyred. The rail link was long gone, and I don't recall obvious surface traces of narrow-gauge rails."[7]

The works manager noted that productivity had increased over the years – output per man-shift was 1.7 tons prior to 1920, when almost every operation in the mine was manual. Cults achieved around five tons per man-shift between then and 1960, thanks to the introduction of compressed air drilling. After 1960, when the Eimco shovel was introduced, that rose to eight tons and after 1965 and the full mechanisation of the mine, thirty tons were output each man-shift. [4] It was estimated that over 8.5 million tons of limestone had been extracted since operations began at Cults a thousand years ago, of which around five million tons were transported by rail.[5]



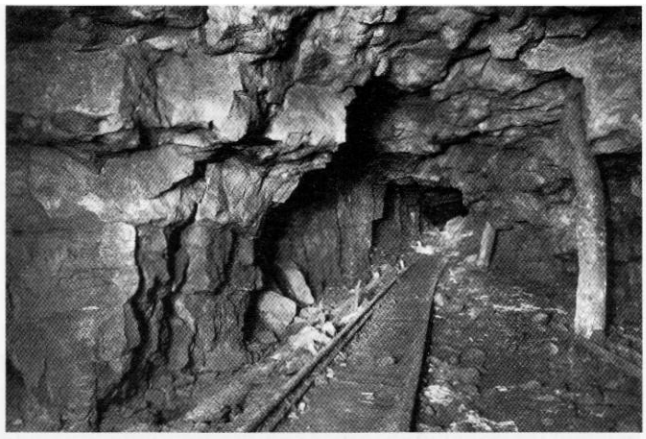
Cults brickworks, prior to demolition: the brickworks made lime-sand bricks, and the autoclave used to cure them lay inside the utilitarian building on the left. The hoppers in the background fed the brick-making machines

Once on the surface, the limestone was destined for either the brickworks, or agricultural lime. The former was directed into a rock feeder, up a conveyor, through a three-inch screen and into the primary crushers, and from there into further screens and a secondary crusher.[4] The 40-ton brick press made 2,500 calcium silicate bricks per hour. "As I recall, the limestone was milled to flour, then blended with water, sand and gravel which was trucked in, and fly ash from Longannet and Kincardine Power Stations. This was extruded and formed into bricks which were stacked (by hand) onto pallets and steamed at 100° C for a week. Not all the limestone went into bricks. A

lot went for agriculture (chicken food as well as the obvious), as well as some being ball-milled with stearic acid to make a wall wash for coal mines."[7]

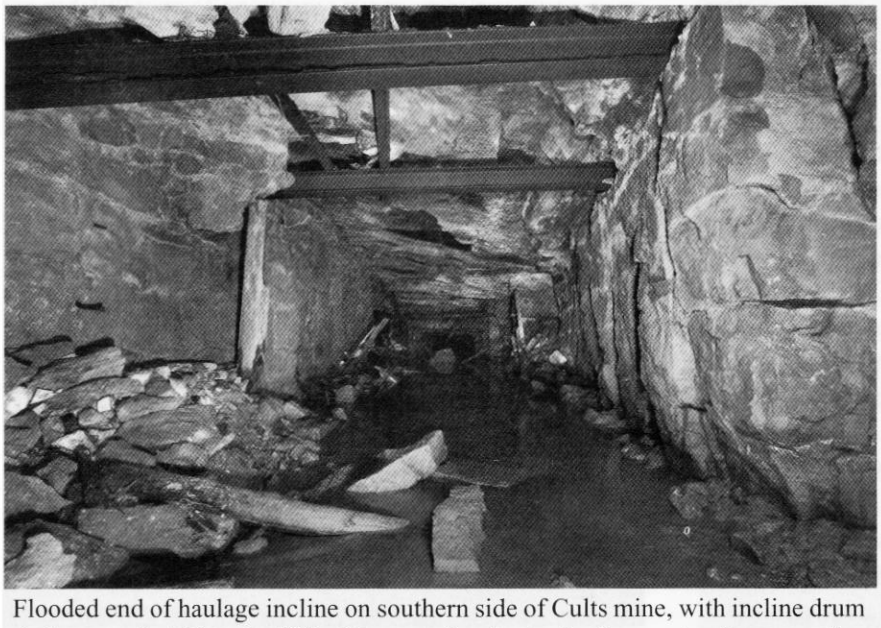
By 1977, "The older part of the mine had been abandoned – the magnesium content had been higher than wanted; because of the jointing of the rock, once abandoned, the roof would gradually fold down making extending the operation through the closed area unfeasible. The working was limited geologically in the other direction, so effectively the end was in sight."[7]

Operations were now concentrated in the Skelpie district, on the eastern side of the crossroads: it had been opened up in 1969, and had reached over 100 feet deep below the surface. The old mine was abandoned in the early 1970s when the limestone seam dropped 80 feet below the level of the working face – which was already well under the water table, and needed constant pumping to keep the tunnels clear of water. Skelpie produced 200 tons of limestone each day, and at that time was expected to last a further five years before the limestone dipped away out of reach.



Narrow-gauge rails in older haulage at southern end of Cults mine: in the deeper, more inaccessible parts of the mine, rails remain in place including these ones, of approx. 20lb/ft "bullhead" section and fixed to the sleepers using spikes

Half a mile further on, the mining engineers discovered a dyke of intrusive igneous rock to the east, which formed a barrier which is roughly in line with Skelpie Farm on the surface, so the mine was driven southwards, following the dip, until it began to hit poor rock towards the end of the Seventies, after which exploration continued southwestwards. Groundwater pumping at Skelpie was more systematic than in the older parts of Cults, with a station set up near the mine mouth, housing a bank of large capacity Mono pumps running automatically, with at least two on duty and one standby.[12]



Flooded end of haulage incline on southern side of Cults mine, with incline drum (submerged). Although difficult to examine due to the deep water, it appears the return drum of the incline haulage system is at least 4 ft in diameter

Skelpie was operated using the "Room and Blast" system of mining: as before, blasting was carried out using gelignite charges, and 100lb of gelignite was set each day, in four or five places around the working face. Each of the blasts brought down 40-60 tons of limestone. As in Cults mine to the west, the limestone band is around twelve feet thick, underlain by fireclay; occasionally the miners came across small pockets of coal. The main haulage was 22 feet wide, at least 8 feet high, and had regular lateral galleries which had already been exhausted.

Skelpie

Although the two mines, Cults and Skelpie, appear contiguous, good safety practice meant that the old Cults drives were stopped up, to create a 45-yard barrier between the old and new workings. Both mines comprised a working vein nine to twelve feet high, with a three-foot limestone roof above, itself overlain with blaes, and a four-foot-deep fireclay pavement below the workable limestone. Robert McKenzie (we assume he was Tom McKenzie's brother) was one of Cults Lime's Mine Managers during the 1960s, and under his supervision, the development of Skelpie took several years, and over a dozen bores were made during 1967 and 1968 – with a new mine mouth formed to the southeast of Cults crossroads.

The end in sight

By the late 1970s, the working face was over two miles from the surface, and all work at the face was carried out using head-torches. Compressed air was fed into the working district of the mine using pipes – the Atlas Copco drills were still in use, as was the Eimco rocker shovel, which was also air-powered.[11] Generally, no pit props were needed in the galleries, as the limestone was always worked "within the seam", leaving a shell of limestone two or three feet thick above the adit, plus pillars of stone where the mine opened out. Theoretically the limestone

is self-supporting – but a series of roof collapses in the older parts of the mine proves otherwise.

On the surface was a team of electricians, engineers, mechanics and a blacksmith – plus offices and a fleet of lorries, the company favouring ERFs in later years. Cults Lime Co. had eight tractor units, with a mixture of bulk tankers for the lime powder and slurry, tipper trailers for the crushed rock, and platform trailers to take the pallets of bricks. After the Skelpie mine closed in 1987, Cults Lime concentrated on opencast working of the limestone, although traces of the quarrying activity are also gradually disappearing, thanks to remediation work and rampant vegetation. The limeworks was still producing crushed lime for agricultural purposes in the 1980s. Latterly, Wemyss Brick Co. worked the Brotus Quarry, and some of the older shallow galleries of the western district of the old quarry were untopped.

Operations wound down at Cults in the early 1990s, and while the mine mouths were blocked many years ago, now a good deal of the surface workings have gone, too. The calcining kilns were dismantled at least a decade ago, and the brick works were demolished in 2009. The old pot kilns are listed, though, and will hopefully be restored one day.

Acknowledgements

Thanks to Gavin Saxby for his initial research into Cults and for providing the initial spur to investigate it; to Richard Black who accompanied me on most of our trips underground, and whose local knowledge proved invaluable to our research; to the staff of the Cupar Library Local History Dept.; to the staff of the British Geological Survey's Map Room; and to the former Cults worker who provided first-hand testimony through the anonymous conduit of the internet.

All photos by Mark Chalmers

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FROM THE ARCHIVES

Cellars or 'crypts' at Rochester, Kent

Considering that one might almost claim that 'no English parish history can be considered complete without a secret tunnel' it is somewhat puzzling that Smith's history of Rochester is almost devoid of any mention of any underground sites! Given that he fails to include a chapter on fortifications younger than the Castle (perhaps on the grounds that they might still in 1927 be regarded as a military secret) there is a complete dearth of mentions of tunnellings and delvings into the chalk which underlies the whole city. The World War II air-raid shelter tunnels and Shorts' contiguous subterranean factory on the right bank of the Medway, of course, were still in the future when he was writing between the two World Wars. Strood, on the left bank of the river, certainly had chalk mines (below brickfields at Frindsbury) but this was outside the city limits.

All Smith (an Alderman, and Mayor of Rochester for the years 1903 and 1904) offers us is brief mentions of 'crypts' or cellars below several of the public houses (the George Inn and the Crown Inn), the Old Vicarage on Boley Hill, and the Bishops' Palace on St. Margaret's Street.

Of these he tells us (on page 478) that …

An old house in the High Street, built about 1300, and then occupied by some person of importance, possessed a vaulted crypt. That crypt still remains, though the original and probably other succeeding houses over it have been pulled down. The present house is known as the George Inn. The crypt is oblong, fifty-four feet in length, sixteen feet in width and eleven feet in height, and divided into four bays.

Another crypt existed under the old Crown Inn, and dated back to 1300. This house was occupied by Symon Potyn in 1316. Subsequently it was frequently used as the temporary resting place of many royal and distinguished persons.

The Old Vicarage, on Boley Hill, and which originally formed part of Satis House, has a small crypt existing, and probably extended beyond its present limit.

Under the present Bishop's palace in St. Margaret's Street, formerly known as the Old Palace, there are two bays remaining of an old undercroft, similar in character to that under the Old Vicarage.

On page 287 he also mentions the crypt at the Cathedral.

SOURCE: SMITH, Frederick Francis, 1927, *A history of Rochester*. London: The C.W. Daniel Company: xvi + 523pp + plates.

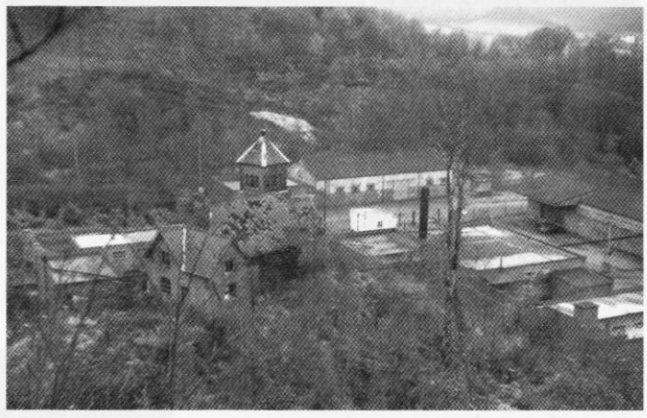
Drakelow's Central Secret

by Steve Fox

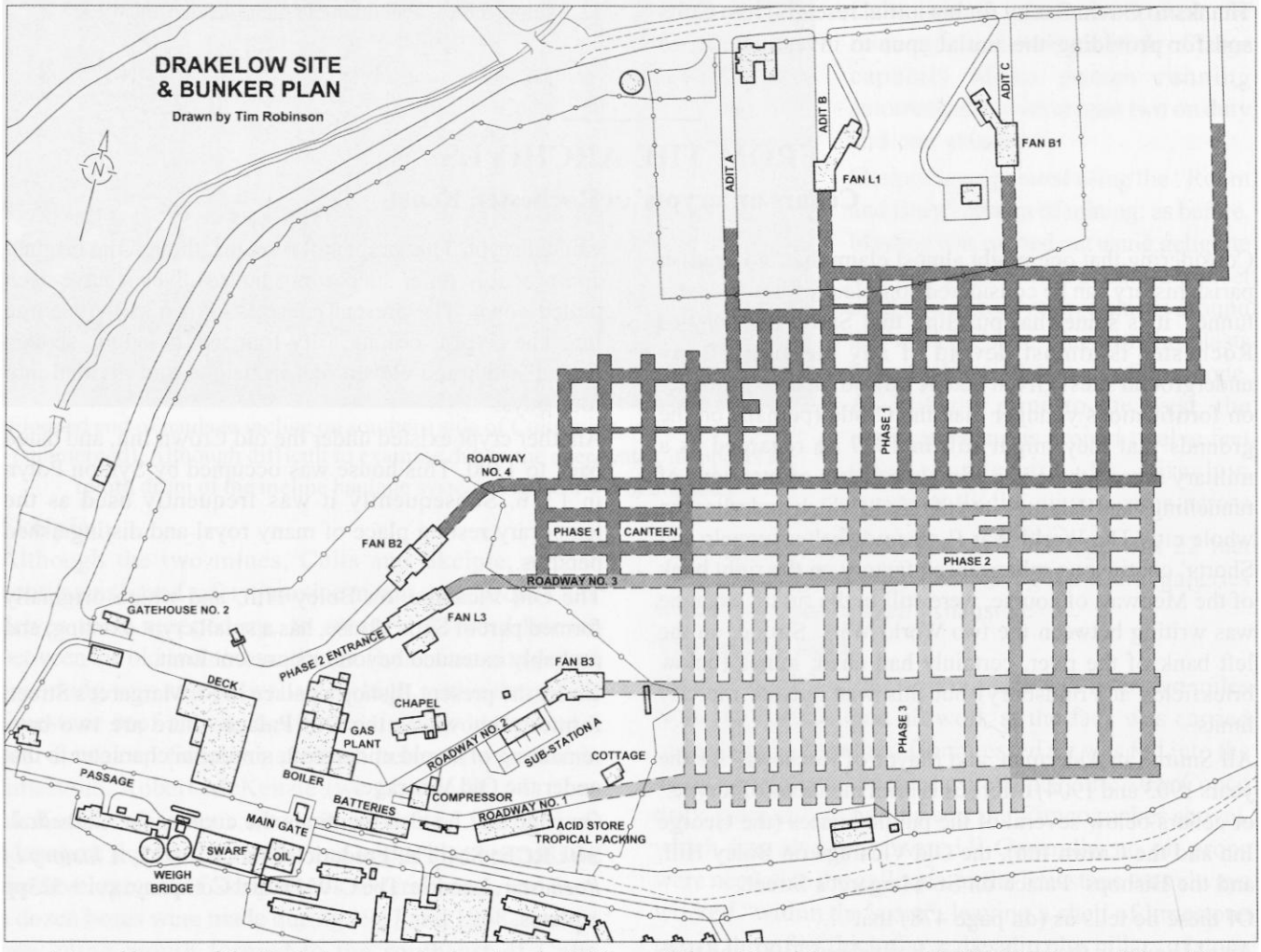
The main entrance to the wartime factory site

We have known for many years that the tunnels at Drakelow, hidden deep in the Staffordshire countryside some seven miles north of Kidderminster, were the home of Regional Seat of Government RSG9 but recently a new and more interesting role has been revealed for them. As files covering the Central Government War Headquarters at Corsham have been released at the National Archives, they have shown that Drakelow was designated to house a second central government war headquarters as a reserve for Corsham, although the histories of the two sites would be very different.

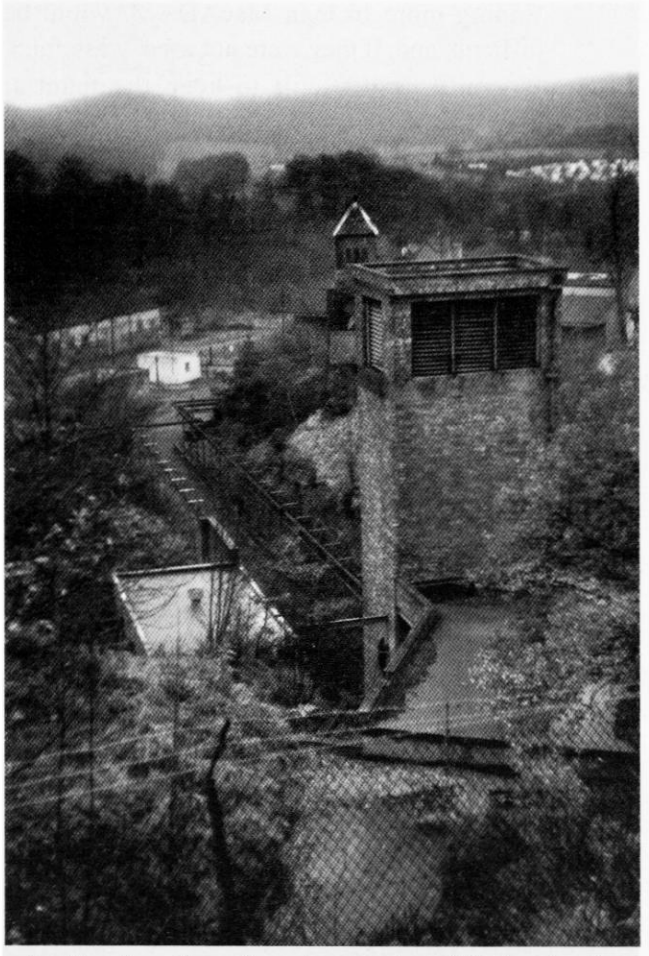
For fifty years this plan for Drakelow was as closely guarded as the existence of the Corsham headquarters and was covered by the same super-secret classification of "Top Secret – Acid". Even fewer people knew the "central secret" of this second headquarters – the



View from above the tunnels showing the wartime factory site with the tower of the 1855 chapel (later school) in the centre



Internal layout of the Drakelow tunnels showing the RSG area (Phase 1) and the proposed LINSTOCK areas (Phase 2) together with some of the original buildings in the factory yard.



Looking from above the entrance to tunnel T2 showing the ventilation tower, one of which was built at each entrance

knowledge of both its location and its function – but now the story can be told.

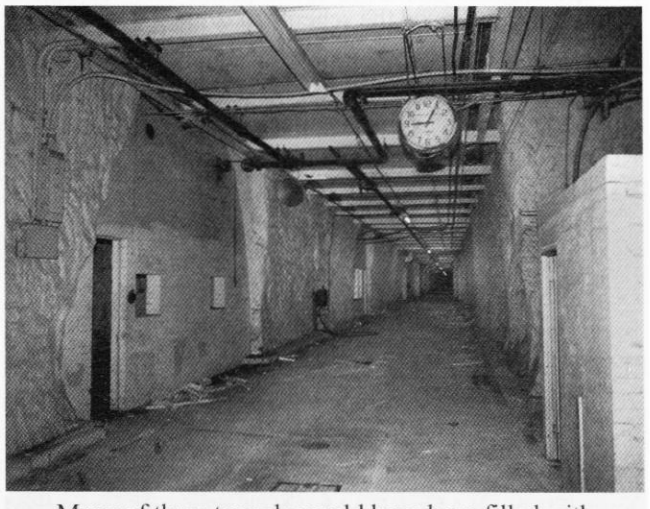
The Origin of Drakelow

The tunnels at Drakelow were dug during World War II to serve as a "shadow factory" with a work force estimated by Paul Stokes to have been between 500 and 700 producing spare parts for aero-engines and as a secure store area for the RAF. The tunnels are laid out in a precise grid pattern with four main access tunnels each with an entrance running in parallel west to east. These are 16 feet wide and 18 feet high and two of them are approximately one-sixth of a mile in length with the other two being slightly shorter. These tunnels are linked at right angles by numerous shorter tunnels or galleries which provided the main working and storage areas. The factory continued to be used into the early 1950s after which it was used as a general storage depot by the Ministry of Supply.

Planning an alternative Government HQ

At the same time as the factory was running down, in Whitehall senior civil servants were preparing for World War III and planning to ensure that a central government would survive somewhere, in some form, if Whitehall were destroyed by enemy action or if the government decided to evacuate from London to somewhere safer. Initially, plans were made with the atom bomb in mind but by 1955, following the horrific findings of the Strath Report, the much more deadly hydrogen bomb dominated thinking. The planners, headed by Sir Thomas Padmore, concluded that the only option was to plan for a nucleus of central government to operate during and after a war from somewhere in the country.

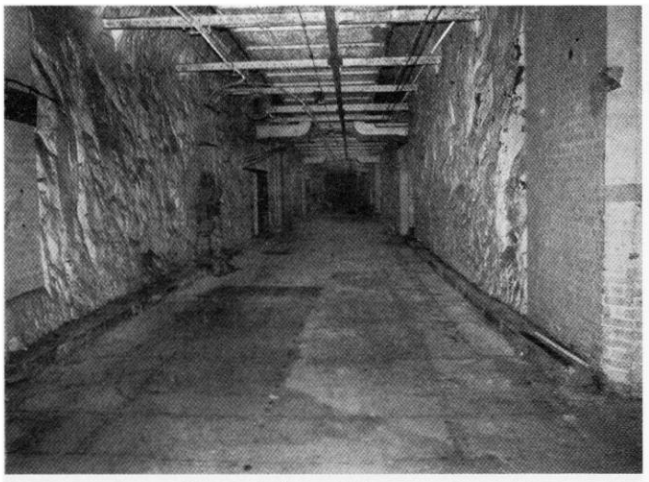
A site at Corsham near Bath codenamed SUBTERFUGE was found and plans put into effect to turn its caverns into a fully operational headquarters for the Prime Minister and some 4000 staff. SUBTERFUGE was however always considered vulnerable and a second reserve site was found and earmarked at a site codenamed MacADAM which we now know was the Drakelow tunnels. The basic idea was that in the run-up to war the main team of ministers, their advisers and support staff would leave London for SUBTERFUGE where, in theory, just before the first H-bombs wiped out London, the Prime Minister would join them. At the same time a smaller team, of say 1500 – 2000, would establish a reserve headquarters at MacADAM ready to take over if SUBTERFUGE were knocked out.



Many of these tunnels would have been filled with offices for the central government

Plans initially shelved

However, plans for MacADAM were not taken any further as the idea was that they would not be developed and no actual work would be done until SUBTERFUGE was completed which was expected to be around 1961. Then in 1956 the Ministry of Supply announced that they intended to give up the Drakelow Depot in the following year. This unexpected problem, together with emerging concerns about the survivability of SUBTERFUGE, led the planners to look again at MacADAM. They thought that perhaps it could take 1500 staff although no plans were developed beyond the vague idea that it would be a reserve. The obvious idea of using MacADAM as a general support for SUBTERFUGE does not seem to have occurred to the planners. The plans, thin as they were, were put back in the filing cabinets. However, the theoretical reserve headquarters was still kept on the "order of battle" and forty telephone and five telegraph



General view of the tunnels

circuits were planned to link the two headquarters although it is unlikely that they were ever installed at either end.

MacADAM – will it or won't it be?

The central headquarters at Corsham could only provide a minimal strategic level of government so Padmore's committee continued the scheme of dividing the country into wartime regions each headed by a Regional Commissioner who would organise the survival and recovery from the nuclear attack at a local level. The Regional Commissioner and his team of some 450 would be based in a purpose-built headquarters originally called a "joint civil-military headquarters", the first one of which was to be built in Shrewsbury. But as usual with home defence preparations money, or rather the lack of it, immediately became a problem.

By 1957 the purpose-built regional headquarters had been abandoned in favour of cheaper, smaller, ad hoc emergency ones. The planners looked around for suitable accommodation for these new buildings and their eyes soon fell upon MacADAM which was still earmarked as the site for the reserve central government war headquarters. In 1957 the idea gained support of using MacADAM for both a regional and a central headquarters possibly with combined functions and staff.

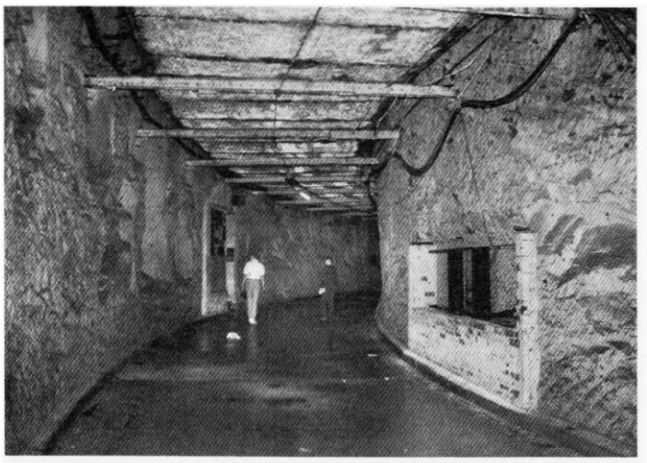
But by now concerns were emerging about finding 1500 staff to man MacADAM given the demands that would be imposed by the needs to staff Corsham and the regional headquarters, and also whether MacADAM was the best site available. After considering (and rejecting) the designation of one of the as yet unbuilt regional headquarters or the unprotected Scottish Central HQ at Lanark as the reserve site, MacADAM was reinstated. In 1958 the Home Defence Committee's sub-committee on the Machinery of Government in War which supervised all aspects of SUBTERFUGE considered the whole concept of a reserve headquarters at MacADAM. They found three basic problems with it:

1. Given the numbers of ministers and senior officials (civil servants and military) needed to man Corsham and the regional headquarters, finding more to man MacADAM would be difficult, and, if they were not used, wasteful.
2. It would be difficult to keep the team at MacADAM informed of events leading up to the war and unless Corsham were destroyed it would have no role. But if it was needed it would not have the staff and facilities to fulfil even those basic functions assigned to Corsham such as control of shipping and diplomatic relations.
3. Its status. The Prime Minister (the original or any replacement) and the senior ministers would go to Corsham and other ministers would be appointed as Regional Commissioners. The ministers sent to MacADAM would be of relatively lower rank so that if Corsham were knocked out there might be problems with some Regional Commissioners outranking those at MacADAM who would supposedly be in charge.

The entrance to Tunnel T4 (2010) which served the RSG. LINSTOCK would have used the adjacent T3 which was blocked in the 1980s. Photo Chris Rayner

Drakelow Suitability

The sub-committee decided that MacADAM could not function as an operational headquarters and as it would be impossible to duplicate the staff and facilities at Corsham, the reserve site should only be at most "a reserve of experience and authority". The files however do not expand on what this "reserve of experience and authority" would actually do to establish itself as a central government and how it would operate. The sub-committee did however confirm that MacADAM was the best site. It had adequate heating, lighting and ventilation which were maintained. It had a usable floor area excluding corridor blocks and lavatories of 191,222 square feet all on the same level and with excellent headroom. Some of the areas were already partitioned and the rest could be easily divided particularly given the even layout of the internal spaces. (These compared favourably with Corsham which hardly had a straight line in it.)



Inside Tunnel T4 near the entrance. The reserve war HQ would have used the parallel tunnel T3 as its entrance

The sub-committee thought it could easily take 2200 people and these could operate together with the staff of a regional headquarters. The site had so much space that they suggested that it could also accommodate another headquarters such as the national headquarters of a key industry. The idea of developing MacADAM on this basis was approved but planning was deferred until Corsham and the regional headquarters were complete. In reality, funds were so short at this time that virtually nothing was done to prepare even the emergency regional headquarters and even work at Corsham was reduced.

Drakelow becomes QUADRANGLE

The regional headquarters at Drakelow was, however, developed probably from about 1959 and, although not complete, it was used for exercises from 1960 when it was designated as Regional Seat of Government (or RSG9) covering the Midland home defence region. The existence of the RSG meant that the whole space at Drakelow was not to be used for the reserve headquarters and so the codename MacADAM was dropped and replaced by QUADRANGLE and was officially described as "The alternative relocation site of the central government in global war". In reality, nothing was done and the threequarters of the accommodation not used by the RSG was left unused, although it appears that it was ventilated to stop it deteriorating.

In late 1960 the Ministry of Works, which was still responsible for the non-RSG areas, expressed its concern to the Machinery of Government in War sub-committee that the Bishop Committee (which was undertaking a major review of all aspects of home defence) did not appear to be considering QUADRANGLE. There was some hurried discussion but it was decided that it was too late to include it in the report. The Ministry of Works was also concerned that without continuous ventilation the site would fall to pieces but this was costing £25,000 a year. This is of course not much in today's terms but in 1960 it represented a noticeable chunk of the money devoted to home defence and the Ministry questioned if it should be continued.

The sub-committee repeated the line that QUADRANGLE would be needed if Corsham were destroyed in war but there would be problems in finding staff for it. It could exercise, at best, sketchy control but it would be worth having as a nucleus for the re-establishment of a central government. They wondered if the RSG staff could be doubled to, say, 1,000 and the Regional Commissioner take over as Prime Minister if Corsham were lost. But the sub-committee now introduced a new idea – QUADRANGLE would be valuable as a replacement for Corsham in peacetime should the existence of that site become known.

In fact, it was increasingly suspected that the Russians were aware of Corsham and its purpose and would attack and destroy it at the start of the next war. The sub-committee decided that QUADRANGLE should continue to be earmarked for this purpose although lack of funds would prevent its ever being developed as a replacement for Corsham. It looked as if a decision might be made but the story of home defence in the Cold War is littered with examples of decisions being ducked or delayed and in this case the sub-committee recommended to the Home Defence Committee that the Planning Team (actually a spin-off from the sub-committee and which was overseeing the work of preparing Corsham) consider the matter further.

The original servery (2010) for the RSG abandoned when the RGHQ was built. This would have been separated by a wall from LINSTOCK to preserve its secrecy. Photo Nick Catford

New Plans for QUADRANGLE

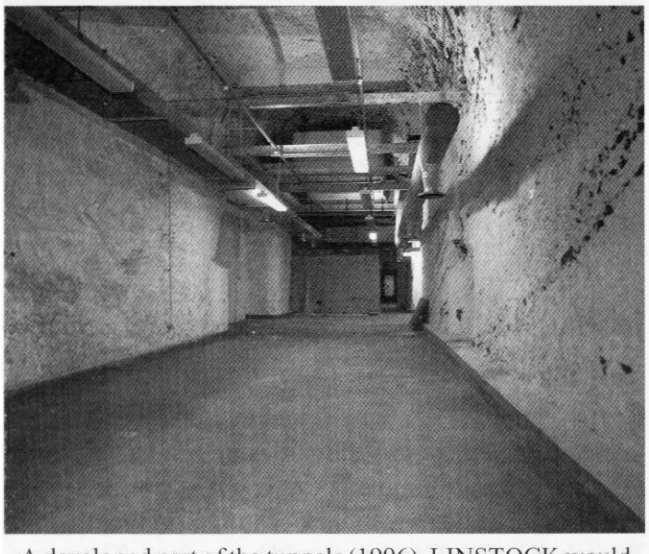
In early 1961 the Planning Team noted that the decision to man Corsham would be so difficult for the Cabinet to take that it might be made too late which might mean that the government would be destroyed at its offices in Whitehall before Corsham could be manned. There was, therefore, a case for setting up a small, inconspicuous headquarters which could be manned by a small senior team without taking too many staff from the Whitehall machine. The available numbers and the limited communications would limit the size of the staff but more

importantly a relatively small staff would greatly help to maintain security and the site could be manned secretly. They suggested a working figure of 300 based on taking ten people for each of the 16 major government departments, twenty to represent the other departments, and 120 for communications and ancillary duties.

The team would be headed by a senior minister with a Deputy Chief of Staff and a Permanent Secretary in support. It would have some minimal communications with overseas governments, the armed forces and military headquarters and also, in a new idea, it could act as a centre for accretion, meaning that government officials could make their way there post-attack to augment and grow the government machine. This is an interesting idea but a moment's thought suggests it would be totally impractical.

The Chairman of the Planning Team now suggested three possible roles for QUADRANGLE. It could be:

1. A reserve in case Corsham were destroyed in war;
2. A replacement for Corsham if it were compromised in peace, although he repeated that there was no money for this;
3. A reserve to house a small, select group who could man it inconspicuously at the start of a period of tension before any decision had to be taken to man Corsham and the RSGs. This was a restatement of the idea previously noted by the Planning Team and was directed at a constant fear of the planners – that of the bolt-from-the-blue attack, that is one where the Russians attacked with H-bombs without any prior warning and without time to put any home defence plans into effect.



A developed part of the tunnels (1996). LINSTOCK would probably have looked like this but with internal partitions for offices, dormitories, etc. Photo Nick Catford

Getting the site ready

The Planning Team had some initial discussions with the Ministry of Works and concluded that QUADRANGLE was still the best available site against radioactive fall-out even with its existing power plant and without any air filters. In periods of fall-out it could operate closed down, without drawing in air from the outside, for several hours. For security reasons, the staff numbers would be restricted to three hundred and the Ministry estimated that it would cost some £34,000 to equip the site for this number. A few months later the Ministry said that the site could be locked down for up to eleven hours and the cost of the minimal facilities would be £20,000 to £25,000 with the main items being a standby generator set, canteen equipment, water storage and alteration of ducting and wiring.

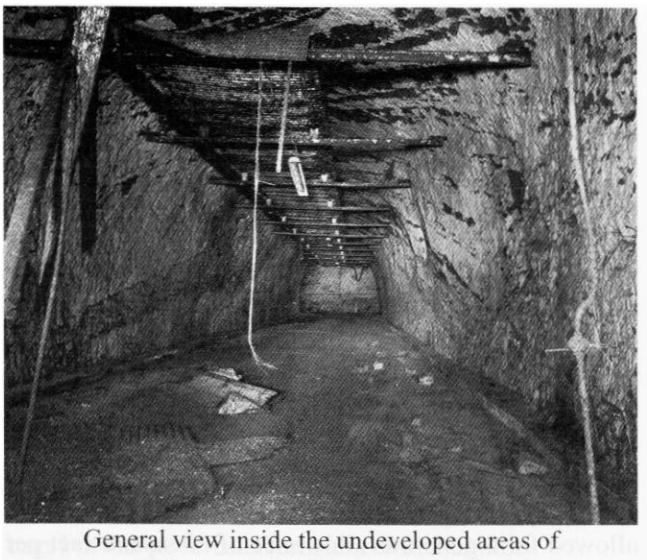
The GPO also considered the communications which would be needed and suggested an 8-position PMBX telephone exchange with 100 internal extensions and 20 common external circuits to public exchanges in Shrewsbury, Worcester and Nottingham. Private circuits would go to the RSGs, War Office communication centres, military headquarters, the BBC, etc. They proposed having 26 teleprinters and 15 autotransmitters with four common-user circuits to Reading. There would also be eight telephone and eleven telegraph circuits going overseas to Canada, USA and our major European allies but as such overseas circuits were inconsistent with circuits provided in an RSG, they would be a security weakness.

Discussions continued into mid-1961 with at one point the Chairman of the sub-committee suggesting that the site was relatively safe from blast as the nearest likely target (presumably Birmingham or one of its satellite towns) was sixteen miles away. The site was however intrinsically less resistant to blast than Corsham and there were never any suggestions of, for example, reinforcing the entrances against blast although it seems possible that by this stage three of the four entrance tunnels had been blocked.

By the autumn the working staffing figure of 300 had been reduced to just one hundred. This would consist of three ministers (which would include the two posted to the RSG), 20 senior staff who would be generalists rather than departmental representatives, 25 military personnel and 50 junior staff for common services work such as cooking and typing. The exact role of QUADRANGLE however still seemed to be rather confused. Now, whilst it could still take over from Corsham if that were destroyed and provide a site for a small team to guard against the bolt-from-the-blue attack, it was now mentioned as a possible general reserve of governing staff.

Ministry of Health

At about this time an interesting idea emerged for using approximately 75,000 square feet of space which would not be needed by either the RSG or the reserve headquarters to hold part of the Ministry of Health's emergency medical stockpile which was stored in



General view inside the undeveloped areas of Drakelow (2010). Photo Nick Catford

Coventry. This stockpile consisted of largely obsolete but still usable and useful equipment which could be used in war to equip emergency auxiliary hospitals and the Forward Medical Aid Units which would give first aid to casualties. It held a huge range of items including:

- 3,260 5" artery forceps;
- 1,440 metal tongue-depressors;
- 2,174 trolleys, oxygen cylinder, large;
- 1,582,702 bandages, 3" rolled;
- 1,025,925 blankets, coloured, wool;
- 64,398 thermometers, clinical;
- 6,444 coats, nurses;
- 6,354 vest, women's.

Although the Ministry of Works said that this would be an expensive way of providing storage space it would have the advantage of disguising the role of the areas allocated to the reserve headquarters and, as the stores would be distributed before any war, the space would be emptied ready to be taken over by additional staff turning up at QUADRANGLE. The idea however came to nothing and was abandoned in 1964 because it was thought that the RSGs would be deliberately targeted at the start of any war.

QUADRANGLE plans shelved

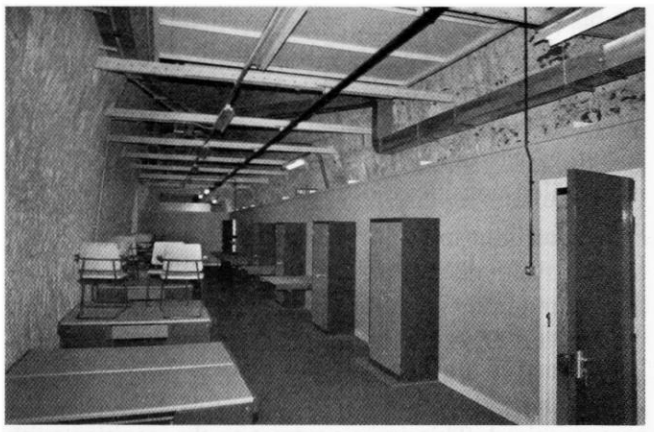
The Planning Team also spent a lot of time planning the final details of Corsham in 1961 and in that year its role was changed slightly so that it would be geared more towards a governing role in the recovery period rather than one in the immediate survival period. However, there was no mention of QUADRANGLE in these plans and in the autumn of 1961 when lists were compiled showing which ministers would go to Corsham and the RSGs, there was no mention of ministers for QUADRANGLE although a list compiled earlier in the year included them. The active planning for QUADRANGLE then seems to have been put on the back burner as there is no mention of it again in the National Archives files until mid-1962. It came again to the fore possibly because of growing doubts about the secrecy of Corsham and the idea that the Russians may have had it on their target lists. The idea that QUADRANGLE could become a post-strike rallying point, to grow the new central government by accretion, was developed – although as usual there were no detailed considerations of how this might work in practice.

But the most important factor was considered to be security and the staff numbers were fixed at one hundred as this number would be easy to hide and the site could be manned inconspicuously in a crisis. If war did not come they could leave without the site being compromised. This is in contrast to the position with Corsham where manning would be a one-off and there would be no chance of keeping it secret if the bunker were not used. Although the initial staff would be fixed at one hundred it was proposed to provide facilities for up to 200 to allow for the expected accretion. The site would be needed for at least thirty days after the attack (which was seen as a short, once-and-for-all event after which the war would stop as all the combatants would have been destroyed), but after this the staff could relocate to a more suitable above-ground site.

QUADRANGLE – the go-ahead

In August 1962 the Prime Minister (Macmillan) gave oral approval for the development of QUADRANGLE and at the same time approved the idea to put even smaller last-ditch reserve teams into some of the RSGs under a plan known as TACK. The Machinery of Government in War sub-committee was now given formal approval to draw up detailed plans and to proceed with the necessary infrastructure work within the original estimate of £25,000 although this had been based on a staff of 300. Security was still considered to be of prime importance and it was decided that the staff of the RSG should be kept separate and in ignorance of the QUADRANGLE staff until war broke out. The two sites would be physically separated by soundproof walls, although these would be provided with doors so that the two teams could work together after the attack.

Bunks in the RGHQ. These appear to be a standard type and taken from the RSG., LINSTOCK would no doubt have had the same



Inside the RGHQ. The reserve war HQ would probably have looked similar

The RSG used entrance Tunnel 4 so QUADRANGLE would use Tunnel 3 as its entrance. The idea was that the staff of one hundred could all arrive at the same time in coaches which could be driven straight into the entrance tunnel and parked there so they would not need to leave the site and would be completely hidden. The staff would also arrive before the RSG was manned so they could be quietly locked away from the RSG staff of some 450 who were expected to arrive later in the pre-attack Precautionary Period. The Planning Team also discussed the idea that with a staff of one hundred they could become a semi-permanent team and could train and exercise together. This was something that would be impossible at Corsham with its much larger staff and which was one of its many weaknesses.

The need for secrecy required a cover story to explain any development or activity at the site. This story would have to be simple and match the known facts but not suggest somewhere important enough to be targeted in its own right. The story concocted with the aid of MI5 was that the site was to be the base for "a wartime intelligence unit". This was considered to be suitably vague and the use of the word "intelligence" would justify the levels of secrecy. As a further security precaution the codename QUADRANGLE was replaced by LINSTOCK.

Drakelow becomes 'LINSTOCK'

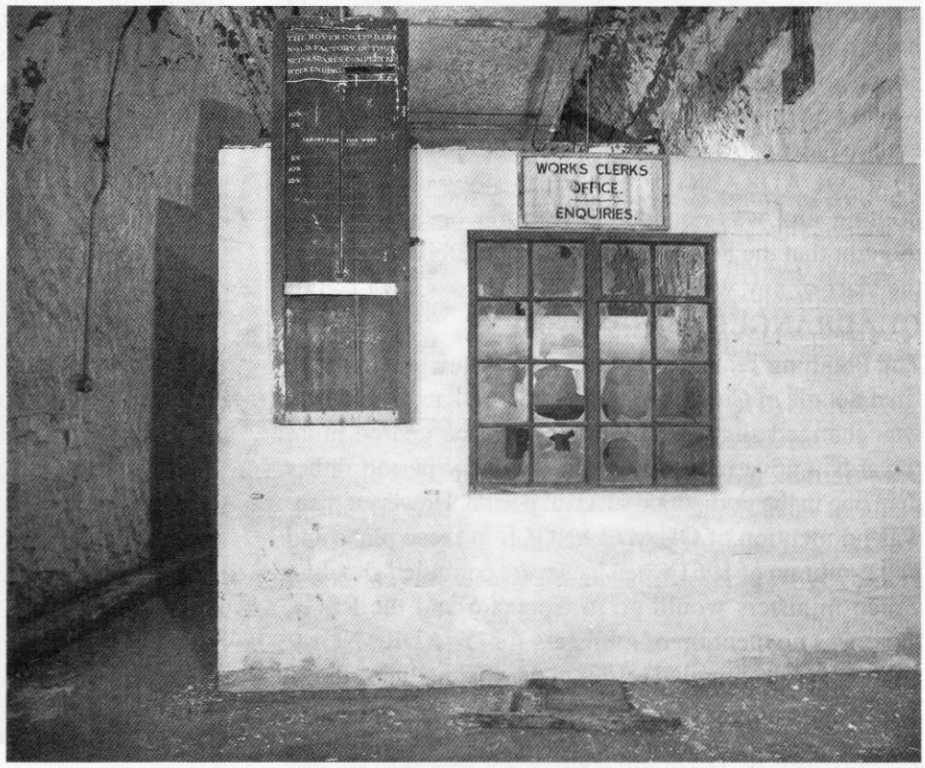
Some thought was now given to the detailed staffing but again this was on a very low-level basis and the government departments concerned were not approached to discuss the numbers they would need and the roles of their staff. The bolt-from-the-blue role was now considered the most important one and it dictated the staffing. LINSTOCK could not be expected to provide a full government of any kind but it could communicate with our allies and show the civilian population that a government still existed and then form the nucleus to expand to organise survival operations.

The regional office of the Ministry of Works was told to start drawing up detailed plans for the site giving particular attention to the space required for staff and equipment; the effect of shift working; the effect of separation from the RSG on ventilation and air filtration; the need for any special temperature and humidity controls for the communications equipment and welfare facilities such as a sick room and a rest room. The space available allowed for a generous allowance of 80 square feet per person with the accommodation being largely along and off corridors 3 and 4.

Detailed plans for occupation

Dividing up the space allowed for an office and a separate bedroom for the reserve Prime Minister complete with "ablution facilities". In addition, 14 separate offices were proposed of 120 square feet each for senior staff and six of these would have sleeping accommodation. There would be a further 14 partitioned offices and four open-plan working areas. Further working space for 54 would be included to allow or expansion.

The 16 communications staff would be housed in the communications area. Junior staff would work on a shift basis but the senior staff would be expected to work as necessary. The Post Office were given two offices plus



The old factory works clerks office (1996). This area would have formed part of LINSTOCK. Photo Nick Catford

2,500 square feet of floor space for their communications equipment. There would be a large conference room, a secure store room for records, 6 to 8 dormitories with single beds for 185 (this was later amended to two-tier bunks to double the sleeping accommodation).

There would be a sick bay with two beds and a medical orderly, a "modest" rest and recreation room and a "small, quiet room to serve as an interdenominational chapel". A kitchen and dining room would be installed both of which could cater for seventy at a time. The internal temperature would be maintained at 70 degrees with 65 percent humidity. This latter figure was largely for the benefit of the communications equipment and perhaps stems from the problems which had been found in the RSG where because of dust the communications kit had been put into polythene bags but this just created problems with humidity.

Ventilation would be up to Home Office standards against fall-out and the three existing inlet fans would continue to be used with the air being heated by steam coils fed from the surface boiler house. Water storage would be installed sufficient for 12,000 gallons calculated at two gallons a day for thirty days for 200 people, although the RSG also had a borehole for emergency use. Toilets would be either chemical or water and showers would be provided if the available water supply permitted. A 300kw standby diesel generator and the necessary fuel tank would be installed near the entrance to Tunnel 3.

The end of the plans

The plan was accepted and planning work continued. But in early 1963 the Ministry of Works reported on what it called "Drakelow Phase 2" and said that the estimated cost would now be about £125,000 although this could easily rise to £180,000. But this excluded furniture, communications equipment, and the annual rental costs of the communications lines and general maintenance. This was considered unacceptably high and threw all the planning into confusion. Drastic cost-cutting measures were considered although at best this would only halve the estimate which would still be way above the £25,000 authorised.

The planners were told to "hasten slowly" but by now the whole idea of basing postwar emergency government on fixed sites was being seriously challenged and by mid-1964 LINSTOCK and the TACK plan were abandoned. The tunnels at Drakelow continued to house a regional level control under various designations until the end of the Cold War but all plans to use it as a site for a last-ditch nucleus of central government were quickly and quietly forgotten.

The whole 46-acre Drakelow site was sold by the Home Office in 1993.

Sources

Information on the origins of the Drakelow tunnels and their use as a wartime factory is taken from Paul Stokes' book *Drakelow Unearthed* with his kind permission. The remaining information is taken from a number of documents held at the National Archives mainly from the CAB series.

All photos from the Sub Brit collection, unless stated.

NAMHO Conference 2011

(National Association of Mining Historical Organisations)

The 2011 NAMHO conference will be held from 29 July to 1 August in Shrewsbury. Activities will continue around Shropshire during the following week. Sub Brit is a member of NAMHO; many of our members have attended previous conferences and are pleased to recommend this one to you.

The theme of the conference is '50 Years of Mine Exploration'. Fifty years ago, there was little interest in industrial archaeology and many important mine sites were lost to neglect or the bulldozer. Many more would have been permanently lost but for the efforts of mine explorers.

A series of lectures will run on the Saturday and Sunday, with emphasis on practical mine exploration over the years, and subjects range from local to international. There will also be a series of surface and underground trips from the Friday lunchtime until at least the Wednesday of the following week, for those wishing to extend their stay.

For more information and booking go to www.namhoconference.org.uk or write to

Andrew Wood, Home Farm, Castle Pulverbatch, Shrewsbury SY5 8DS.

INTO THE RED ZONE – Balaklava's secret submarine base

by Julian Allason

The Black Sea may have some way to go before it catches up with Spanish Costas and the French and Italian Rivieras. But don't tell the Russians who have been cheerfully holidaying, not just on its southern coast around Sochi where Stalin's dacha is a big draw, but in what is now the independent state of Ukraine. The Tsars maintained a holiday palace at Yalta and a Black Sea fleet based at Odessa and Sevastopol. It is from the latter, still bristling with Russian naval force, that we headed out for what until 1991 was a non-destination: Balaklava.

Today it has reappeared on official maps and we are crossing the 'Valley of the Four Hundred' over which the Light Brigade charged the Russian guns in a display of military gallantry – and miscommunication – immortalised by the poet, Tennyson. We are however navigating to a more recent site of Cold War – and subterranean – interest.

Memorial to submariners killed in the Second World War erected by sailors outside the main personnel entrance

Cold War beginnings

A century and a half after the Crimean War, in 1954, an elite formation of Soviet sappers began excavating a concealed network of bomb-proof tunnels beneath a thousand feet of hard limestone. Their purpose? To shelter and service submarines of the Black Sea Fleet far from NATO's unblinking eye in the sky. The project's codename was Objekt 825.

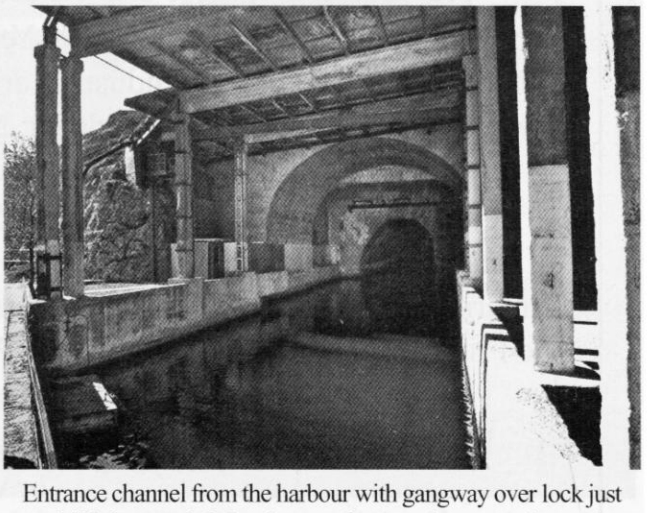
"This is the Red Zone – the nuclear weapons store," says our guide, Dimitri, who served here as a submarine officer. The torpedoes and missiles are gone, removed when Russian forces withdrew in 1991 following the implosion of the Soviet Union. But there is enough defused hardware and infrastructure left despite the attentions of local recyclers to provide a vivid feel for what life was life when the complex was operational. But so far no submarines, although the idea has been mooted of towing in a surplus Whisky class vessel. Not impossible given the opening of one such to the public at Vytegra midway between Moscow and St Petersburg. (If it happens here they could do worse than adopt the Vytegran practice of employing female naval cadets in surprisingly short skirts as guides.)

Cold War secret becomes a museum

Today though Balaklava's 600 metres of echoing canals, each ten metres wide, are filled only with the sea – and memories of the Cold War rekindled by Dimitri, who describes the crew smoking fish caught in the dry dock while his vessel was in for repair. When Nick Catford and Mike Barton visited in 2005 only one side of the complex was accessible. Today the tunnels on both sides of the main canal are open and illuminated in authentically eerie fashion. Hoists and trolleys for moving torpedoes and mines from Red Zone to boat are in position with little of the imaginative licence adopted at some reconstructed bunker sites.

Locked down for nuclear war the complex was intended to protect nine submarines and 3,000 troops for a month. Today its well-concealed entrance is guarded by 150 tonne blast doors – and a ticket collector. For, following the collapse of the Soviet Union, this most clandestine of bases was returned to the Ukraine and cheekily opened as a distinctly unusual naval museum. This the Russians are said to be none too happy about and, following the renegotiation of their leases on parts of the Ukrainian ports for naval bases, displeasure was voiced according to the local press. So 2011 might be the time to visit while this most extraordinary of museums remains open.

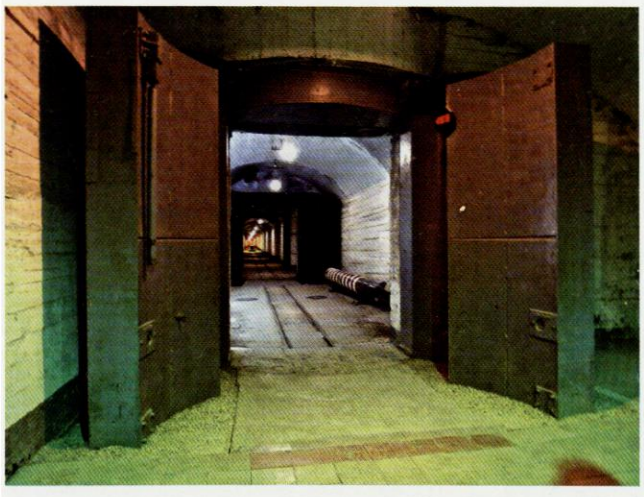
There is no question of Balaklava base being recommissioned though. The present generations of Russian subs are simply too big to fit inside. And the Ukraine says it has no plans to build any of its own, although there are said to be a few surplus Soviet vessels knocking about on the secondhand market if one knows who to ask (Michael de Cozar, concierge of the Ritz Hotel in London, told me he had obtained a warship for an American guest with an interest in militaria!).



Entrance channel from the harbour with gangway over lock just visible bottom left. Steel camouflage netting protecting and concealing entrance upper left has been removed by "recyclers"

Entrance channel from the harbour with rails for protective water gates visible above and gate in open position to right behind pillar

The problem now as then is that the sole exit from the Black Sea is through the Bosphorus waterway, Turkish territory and under close NATO surveillance from two listening stations at the Black Sea end. There is also the small matter of underwater systems in place in the Sea of Marmora. But the Black Sea was – and remains in the minds of naval planners – a key part of the Russian sphere of influence.



First blast door to the Red Zone with defused torpedo visible right and narrow gauge railway for weapons trolley

Nuclear strike protection

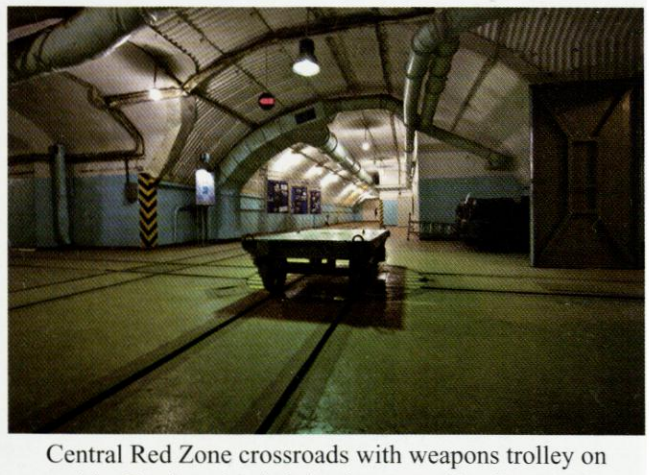
Little expense was spared to do the construction job properly. Both entrances to the semicircular canal tunnels were shielded by steel net and camouflage, largely gone now, concealing 7 x 10 metre blast doors that could completely seal the channel. They were two metres thick and took forty minutes to close to the locked position. Further sets of blast doors protected all access points to the inner area of the 10,000 square metre site. As Nick noted in his original report, the facility was designed to withstand the effect of a direct nuclear strike of up to 100 kilotons. Under 'normal' conditions some 150 personnel were employed inside the base, with a further fifty forming the permanent guard force outside.

The site was equipped with its own independent filtered air supply, powerful diesel generators for use in the event of a failure in the mains supply and underground fuel pipelines fed from tanks holding 4,000 tonnes of fuel on the hillside above with an access tunnel unto the base. There was also an underground narrow-gauge tramway for moving nuclear warheads around. The upper level included the reserve command post for the Black Sea Fleet, bakeries, hospital, mess halls, kitchens, bathrooms, shower rooms, recreation rooms and living quarters for the personnel.

The estimated period of a complete overhaul of a submarine was a maximum of three weeks with the repair always running on time during thirty years of operations of the underground facility. Submarines always entered and exited the harbour at night, so the electricity in the town of Balaklava was regularly shut off during these hours of harbour manoeuvring. Today it is a little better and Balaklava Harbour is filled with flash speedboats largely owned, I was told, by the local mafia. It still doesn't pay to ask too many questions.

Photographs by Jamie Allason, unless stated.

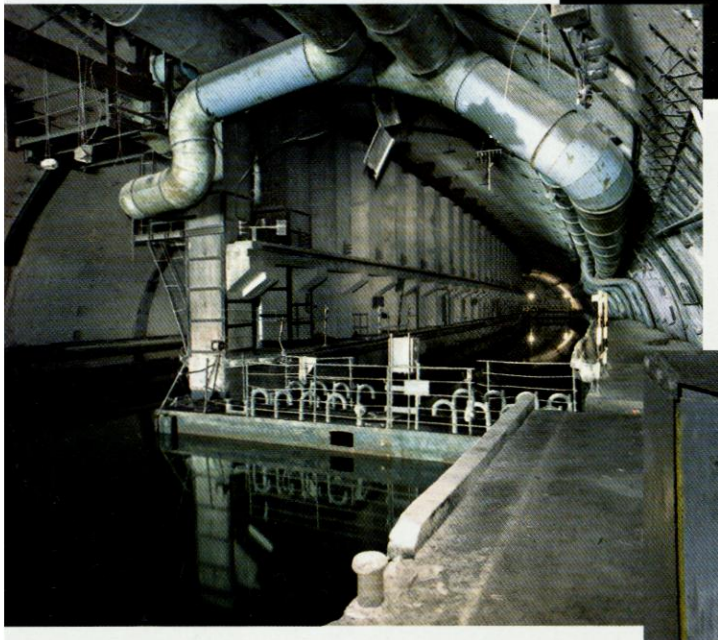
Julian Allason visited Balaklava for the Financial Times *in November 2010.*



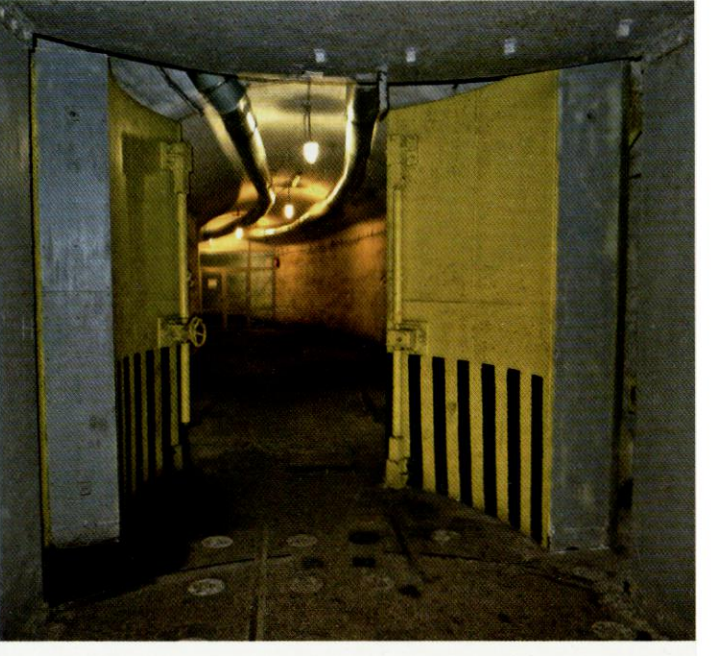
Central Red Zone crossroads with weapons trolley on turntable. Track to the right leads to canal loading platform. Note high explosive blast door right protecting canal, not intended to be proof against nuclear detonation

Provisioning and reequipment dock in the middle of the main channel for rapid recommissioning of submarines. Winch and crane machinery was looted and apparently removed by boat

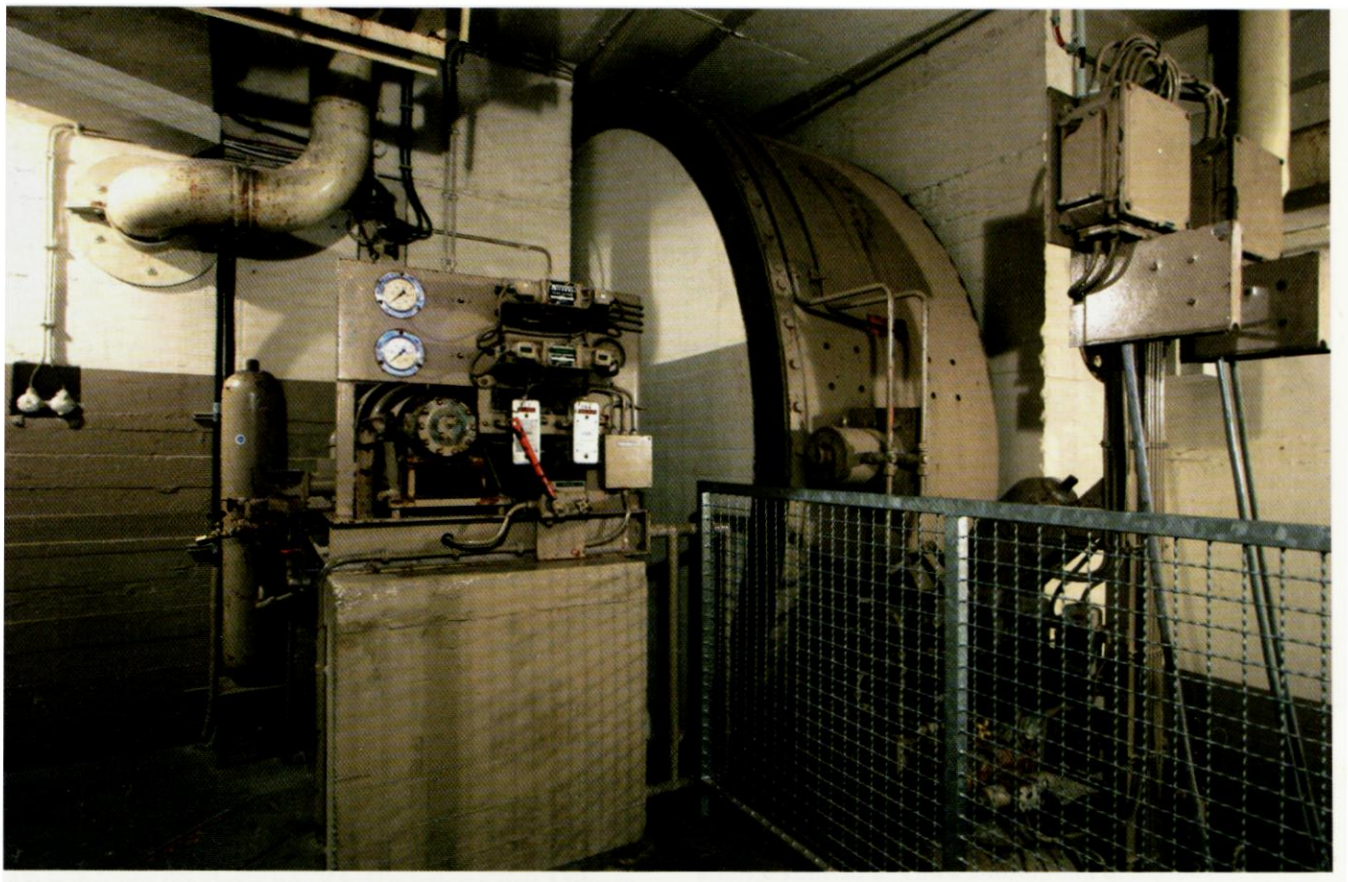
Entrance to dry dock for major repairs. Note full width of tunnel to allow submarines to pass each other



The Dry Dock. Photo Nick Catford



Secondary personnel blast door originally intended as alternative access for weapons delivered from outside. The rails were subsequently filled in



One of two 2.5m-high 25-tonne concrete and steel circular blast doors sited at each end of the Emergency 'Seat of Government' at Marienthal. Photo Nick Catford

View from the control room balcony at the Maidstone ROC Group HQ. Photo Neill Luckett

Broadcast studio at the Regional Control bunker at Urft. This is the control room equipped with a Telefunken six-channel control desk with two integrated Telefunken reel-to-reel tape machines. The announcer sat at a desk on the other side of the window. Photo Nick Catford

Outline of narrow-gauge trackbed in an older part of Cults mine: before the introduction of tractors as motive power, most limestone skips were propelled by hand along winding passages with minimal clearance. This shallow drive meanders for almost a kilometre. Photo Mark Chalmers

How the West was Won…
or more correctly, How the West was *Planning* on Winning…

Day 1 Transmitter Site & Bunker, Kirspenich – by Bob Clary

Twelve bleary-eyed SubBritters left Stansted at unearthly o'clock to arrive at Hahn airport at 0930 on a Saturday morning last July for a four-day tour of West German bunker sites. Hahn is what Ryanair laughingly call Frankfurt, but don't look for it on the map anywhere near Frankfurt. It's an old US airbase situated about sixty miles west of the city literally in the middle of nowhere. Many of its buildings are still painted brown and the airport itself is well worth a day's exploring.

The trip had been organised by Mike Barton and having seen many East German bunkers we were all keen to see what our side had been up to. We were not to be disappointed! We had three cars between us and after the usual fight for the front seats was over and the satnavs had been fired up, we were on our way to meet Mike at the first rendezvous. The first bunker of the trip was to be an underground transmitter site at Kirspenich, a small town about 23 miles southwest of Bonn, the former West German capital city.

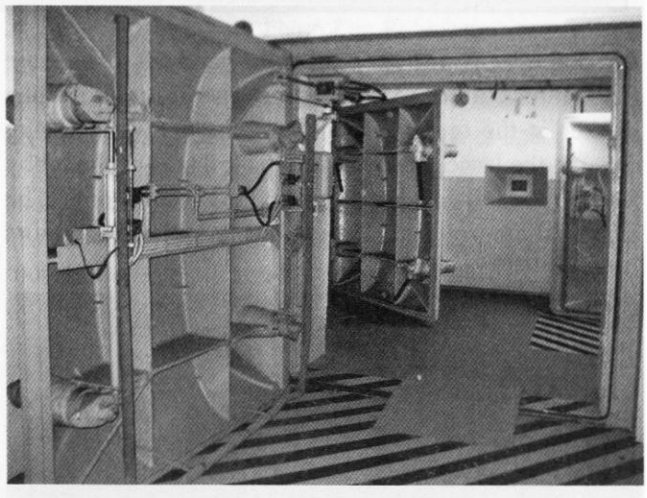
After driving for about two hours north we met Mike in a lay-by and followed him in our cars up a narrow lane past a "No Entry" sign onto a forest road. We were soon driving under the trees and it wasn't long before we saw a wire-mesh fence topped with barbed wire. We carried on driving to the gate. At this point, when we got out of our air-conditioned cars, we realised how hot it was. It was roasting; I, for one, stayed in the shade as much as possible. Inside the gate we met some familiar faces. Some of Mike's German bunker friends whom we had met before such as Peter Rentsch and Paul Bergner had come too, as well as the management team from the main government bunker Marienthal which we were going to visit later in the trip.

Entrance ramp. Photo Bob Clary

Kirspenich bunker was the remote transmitter for Marienthal which was some twenty miles southeast. Planning started in 1961 when the first attempt was made to purchase an old anti-aircraft site but that proved too difficult for the bureaucracy to achieve so another site was found. Its cover was that it was going to be a police radio station. When it was completed in 1964 it became the Bonn government's means of communicating with its NATO allies in the event of war breaking out. It was also used in later years as a diplomatic radio station to contact West German embassies around the world. Modernised in 1994, it continued in use until 1997 when it was closed down. It was sold by auction to a private bidder, Dieter Koppenburg, who hopes to open it as a museum at some point in the future and was our guide.

The site has been kept secure and has not suffered from any vandalism. The power is still on and while most of the transmitter equipment has been removed the air-conditioning still works as do all the lights. The bunker is clean and tidy and in good condition. It has a single floor of some 2,500 square metres and is just beneath the surface having been built by the cut-and-cover method. Its entrance is via a steeply sloping ramp big enough for a large vehicle to enter and unload under cover.

At the bottom of the ramp there is a blast trap and to the right a large blast door. This leads to a lobby with another large blast door to the left for plant access and a smaller personnel door to the right.

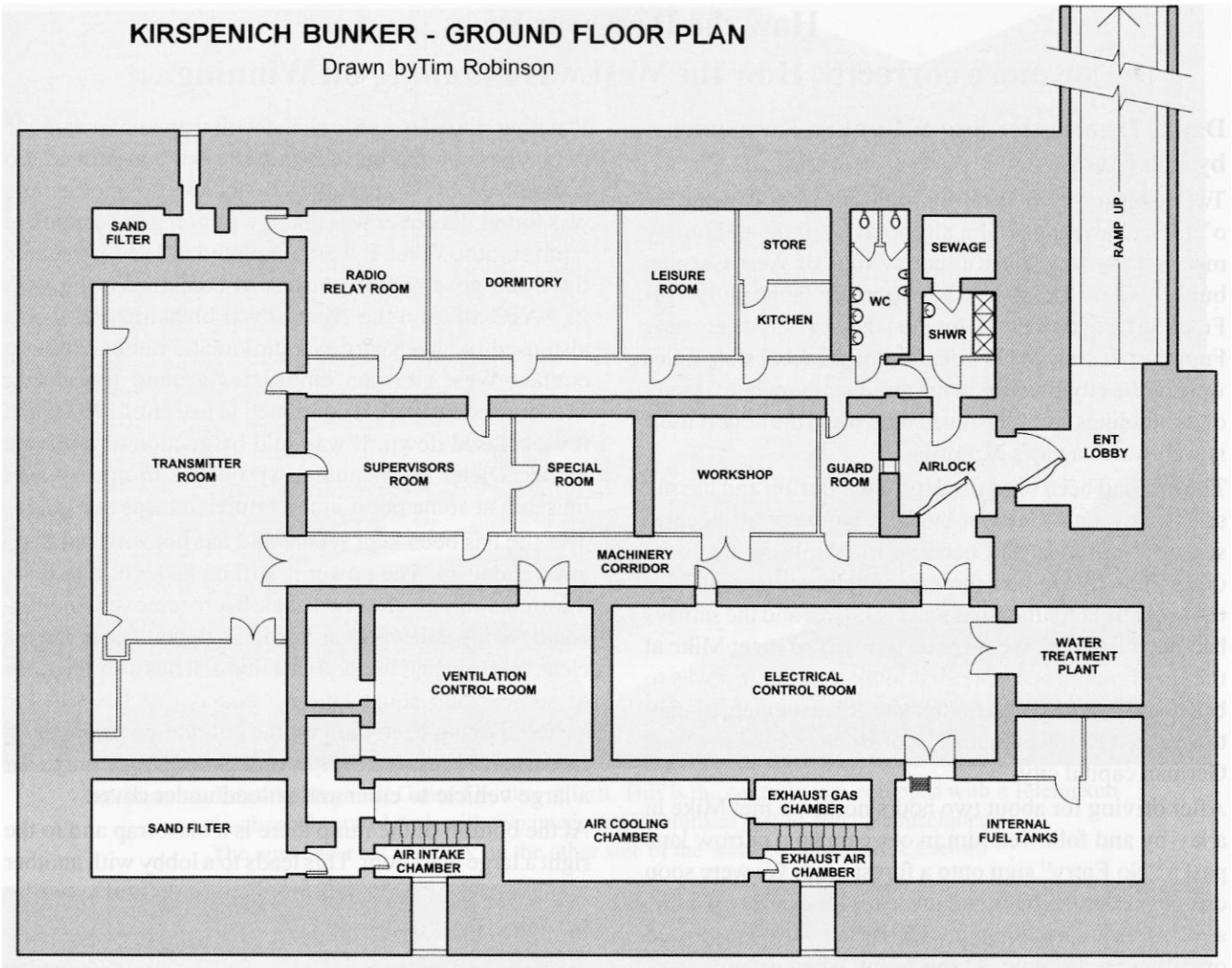


Entrance air-lock. Photo Bob Clary

Straight ahead is a reinforced glass observation window from behind which access would have been controlled from the guardroom.

The bunker was designed to survive thirty days of isolation in the event of a nuclear war and thus contained everything necessary to support the engineers and ancillary staff.

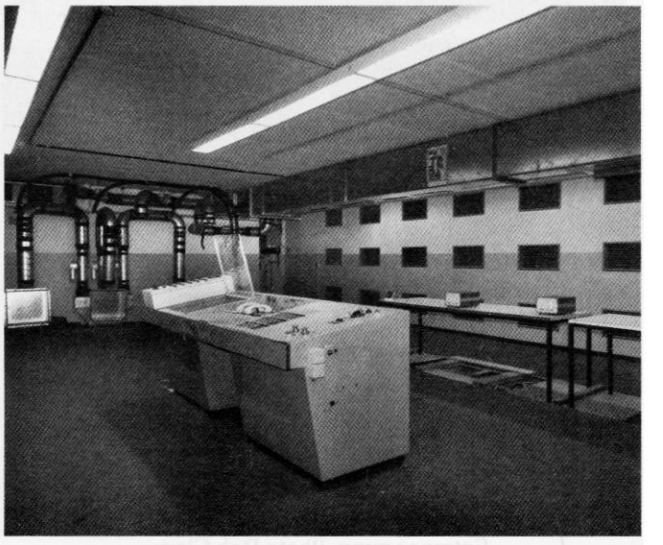
The bunker is divided into three sections along its length with corridors between each section. As shown on the plan the three sections are laid out as follows: plant rooms on the left, operational rooms and workshops in the centre



and domestic facilities on the right-hand side. The main transmitter control room is across the full width of the bunker at the opposite end from the entrance. Going through the large blast door on the left side of the lobby leads to the left-hand corridor and the plant rooms. The electrical control room is first but its diesel generators have sadly been removed.

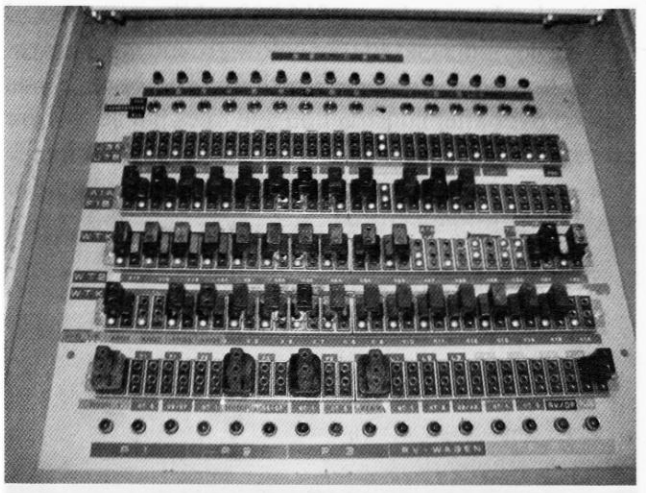
Electrical switch room. Photo Bob Clary

Water treatment plant and diesel tanks are in rooms off this area. Next is the air-conditioning plant room which is still intact and running. Its air-filtration equipment including a sand filter is also accessed from here. On the opposite side of the corridor is the workshop and supervisors office as well as a "special room" we weren't allowed into. The corridor ends at a set of double doors which provide plant access to the main transmitter control room.



Transmitter control room, the transmitters (now removed) were at the far end of the room. Photo Nick Catford

This control room had been stripped of all its transmitter equipment but the main control desk remained with a few of its control panels intact.



Panel in the transmitter control desk. Photo Bob Clary

The position of the transmitters could be identified by the holes in the raised floor where the racks had stood. At the back of the control room was a partitioned-off void which was used for air-conditioning extract. In the corner of the room one transmitter was extant, the one that had been used until quite recently by the police. Leaving the transmitter hall by its personnel entrance we went to the second corridor and back to the entrance via the domestic facilities. The first room on the left was the radio relay room which also leads to the emergency exit. Next down the corridor is the dormitory followed by the rest room and small kitchen. Toilets, shower and sewerage were at the end of the corridor adjacent to the main entrance.

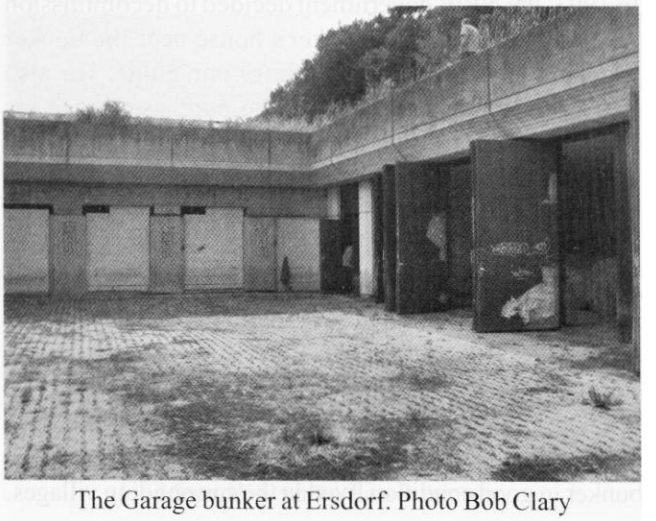
We had a brief guided tour by the new owner and then we all spent a good couple of hours with free access to the whole bunker. We explored and photographed every nook and cranny. When we were all done it was time to go for a tour of the surface to view the aerials many of which were still in place.

Feeders to the antenna being explained by our guide. Photo Bob Clary

The transmitters for reaching the embassies were necessarily low-frequency short wave and thus the aerial arrays were long lengths of wire hanging from masts; there were also higher frequency dipole aerials for more local communications with Bonn. Some were quite hard to see as the trees were in full leaf.

Antenna. Photo Tim Robinson

Having said our goodbyes to our hosts it was time to make our way to our hotel where we would be staying for three nights. As we had a bit of time to spare, Mike suggested that we look in on another site on the way back. It was near a village called Ersdorf and consisted of a series of cut-and-cover garages and underground rooms. It was empty and its function was unknown though it was suggested that it might have been a remote transmitter site with the garages housing mobile transmitters.



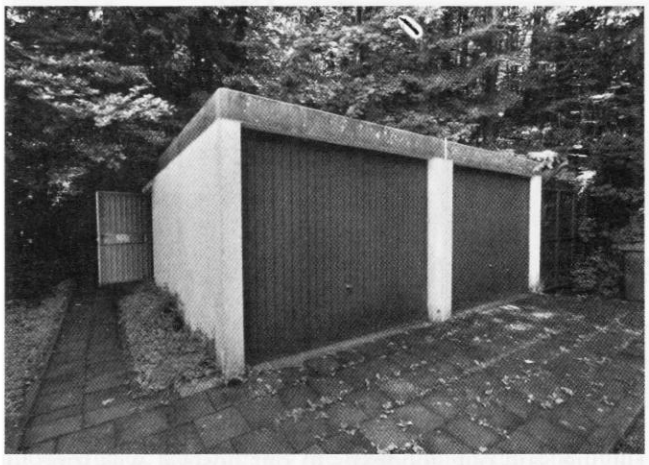
The Garage bunker at Ersdorf. Photo Bob Clary

After spending half an hour or so exploring it was time to move on to the hotel and refreshment. Our hotel at Lahnstein, near Koblenz, could be seen from some distance. It was a large white tower block on top of an otherwise green hill rising high above the Rhine valley. It had great views down the valley and even had its own bunker, but it had one shortcoming, no air-conditioning. The rooms were sweltering and airless. Some people slept out on their balconies which seemed like a good idea until there was a monsoon at 3 o'clock in the morning.

Now read on with Richard…

Day 2 Regional Control Bunker, Urft – by Richard Savage

Having survived an overnight temperature of 30°C in a hotel seemingly transplanted from the former DDR and with an all-pervasive air of genteel decay, we set off to visit Ausweichsitz des Landes Nordrhein-Westfalen (The Regional Control Bunker of Nordrhein-Westfalia 'NRW').



The entrance to the bunker is at the back of a small garage. Photo Nick Catford

As the fear of nuclear conflict increased towards the end of the 1950s it was decided that each state of the FDR should construct a bunker to house its senior officials and which would enable the machinery of (state) government to operate during the conditions of nuclear war. The NRW bunker was constructed in the early 1960s at a cost of approximately 10 million DM (£4.3M).

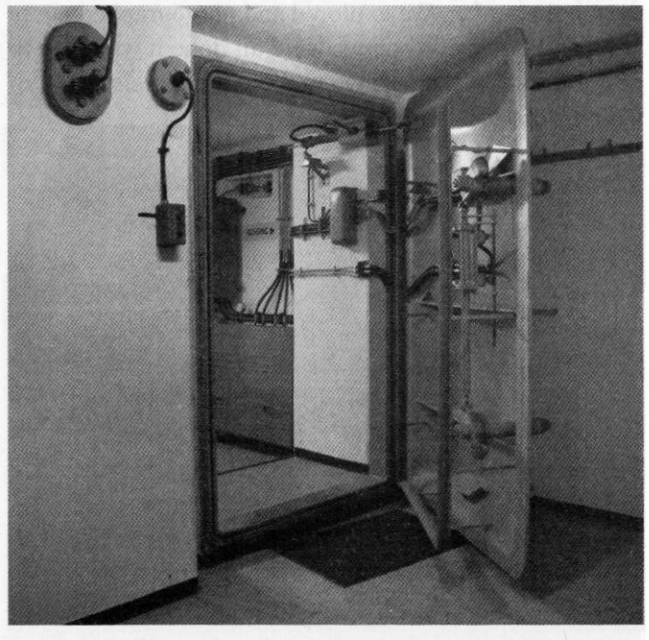
In 1993, the NRW government decided to decommission the complex and the caretaker's house near the bunker was sold in 1997 to Dr Röhling, our guide. He also received the bunker as part of the purchase. Since his father had been involved in the construction of the facility, Dr Röhling decided to open the bunker to the public as a memorial to the Cold War. It was first opened to the public in February 2009.

The bunker is built into a wooded hillside in front of a modest house in a quiet side road approximately 1km south of the village of Urft. Entry to the bunker is via some four flights of steep steps. During its operational life the caretaker for the bunker lived in the house while the rest of the small number of staff required to keep the bunker in good condition lived in the surrounding villages. Locals were deliberately misled as to its true function and were allowed to believe that the bunker was a warning station or water plant.

The bunker has a volume of 16,000 cubic metres spread across two floors and is 16m below ground at its lowest point. Its outer walls are 3m thick. The bunker was earthed over after construction and trees planted where possible. Any exposed parts – particularly the air intake area – were painted green and draped with camouflage netting. Exercises were held every year until 1993 when the NRW government decided to abandon the bunker. During these exercises the participants arrived in small groups so as not to arouse the suspicions of locals. To further disguise the bunker an unremarkable double garage was built at the foot of the steps which were also covered to exclude prying eyes.

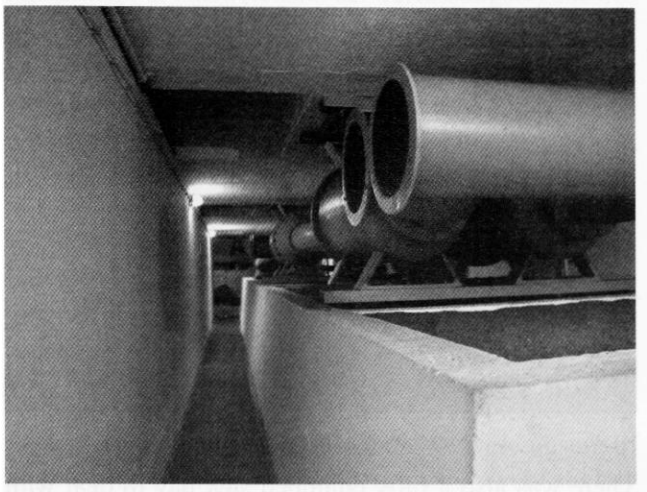
Stairs from the back of the garage lead up to the bunker entrance. Photo Tim Robinson

At the top of the steps a dog-leg passage leads to a series of blast doors and airlocks and so into the bunker.



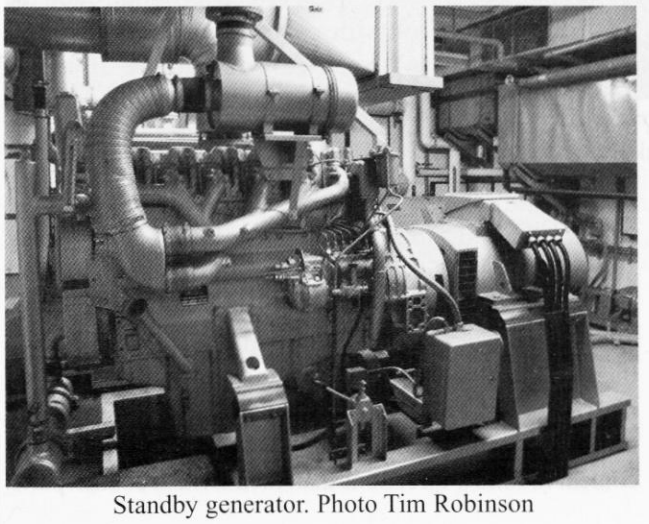
Unusually light-weight blast door just inside the entrance to the bunker. Photo Tim Robinson

The full complement of 200 personnel was expected to work, sealed in the bunker, for up to thirty days. The bunker was fully fitted with all of the complex and seemingly endless variety of equipment without which no bunker is complete, essential to sustaining life in the event of adopting a 'closed down' state. We were led through a series of plant rooms containing the pumps, filters and coolers necessary to produce and maintain a habitable environment.



Air mass cooling system just inside the bunker entrance. Photo Tim Robinson

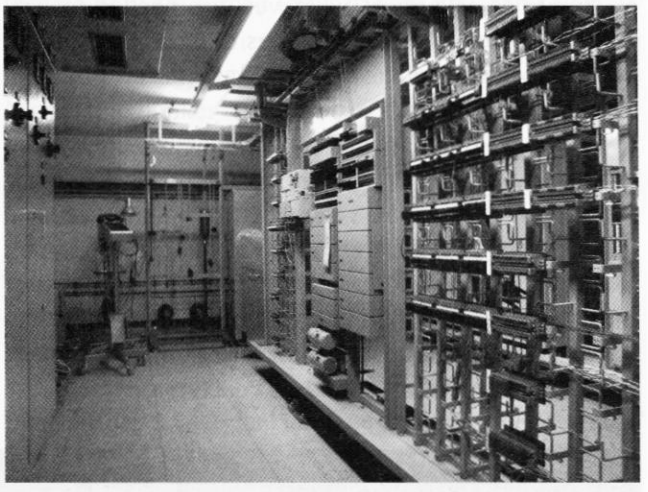
The water supply was remarkable for the fact that the bunker uses semi-raw water for all processes that do not require potable water – a considerable saving on filtration resources. There were rooms filled with control panels monitoring and operating the plant and controlling the provision and distribution of power from both the external grid and the back-up power generators essential to run the bunker. In addition to plant rooms, we were taken through the sleeping accommodation and the canteen. We were treated to some excellent refreshments in the canteen. The hot drinks were especially welcome as the bunker maintains a temperature of 7°C. Suffice it to say that everything was in perfect or near- perfect condition. As part of our guided tour we were treated to the sight and sound of one of the generator sets running.



Standby generator. Photo Tim Robinson

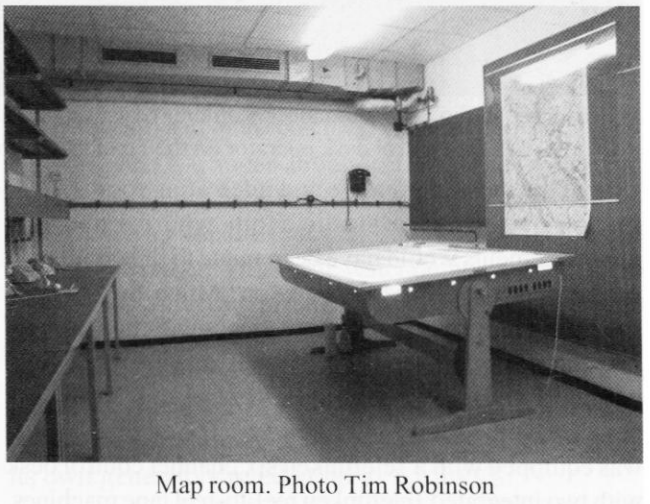
One forgets when wandering around these abandoned dinosaurs of the Cold War just how noisy they would have been when operating 'closed down'. Even the noise of the powered airlock doors made conversation difficult.

Further into our tour we visited the Main Distribution Frame which handled the 300 telephone lines necessary for the State Government to function from within the bunker. As with the rest of the equipment this was in near-perfect condition although, unfortunately in this case, not working. There is a vacancy for an expert who is able to document the operation of the telephone system, possibly with a view to making it work again. In addition to the telephone system, the bunker is equipped with radio and telex systems.



The main distribution frame. Photo Tim Robinson

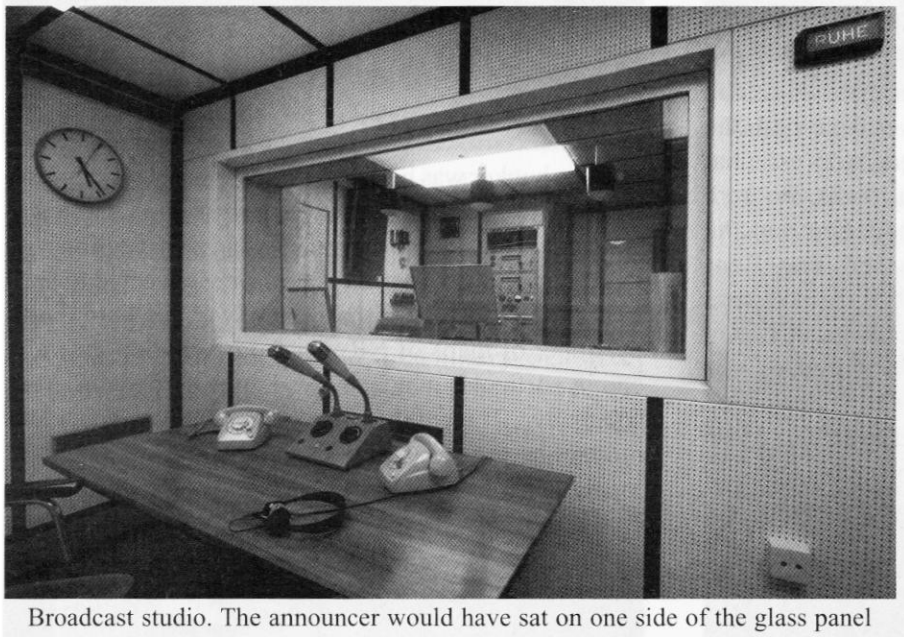
Having explored the support areas of the bunker our tour moved into the control areas. It must be remembered that this bunker was built to house the State Government, i.e. it did not have an offensive function, and that it was anticipated that its primary role would be in dealing with the huge number of refugees that were expected to head west along the Rhine in the event of war. We were shown a number of maps of NRW and our attention drawn to one in particular which showed arterial roads in green and mauve. The number of mauve roads, designated for military use only, far exceeds those shown in green and for civilians.



Map room. Photo Tim Robinson

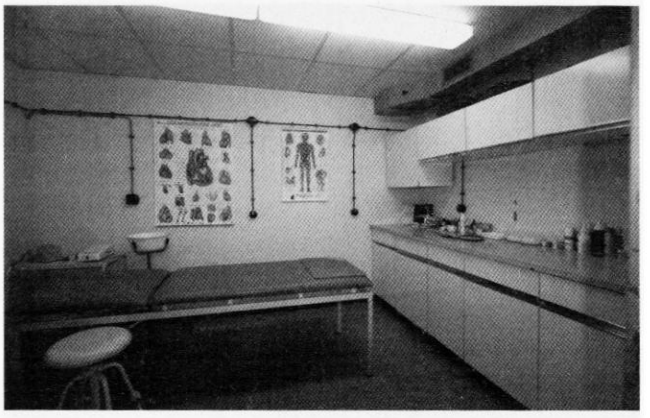
So, not only were the politicians incarcerated in the bunker, or more realistically their civil servants, having to deal with a huge influx of people, they were having to do so on only a limited number of routes. In fact a whole section of the bunker was devoted to traffic management and was even able to call upon the component parts for seven temporary bridges stored at Rheinschiene, ready to be assembled to provide additional crossing points for the refugees. This section was tasked with coordinating the movements of the refugees through contact with civilian staff on the ground via telephone, telex or radio. Other departments were tasked with looking after those injured and in panic, and in need of food and water and shelter. In a typically bureaucratic way, there was nothing as simple as seizure of whatever was needed to deal with the crisis. Anything that was requisitioned – be it food or accommodation – was valued and payment agreed.

It went further than that: if the state officials wished to do something whose legality was uncertain they were able to call upon lawyers with a fully equipped legal library, a very expensive library considering the premium placed on any space in a bunker – the majority of staff 'hot bedded'. Dr Röhling explained that, should the lawyers fail to come up with the legal argument to support a decision, legislation would be enacted to remedy the deficit.



Broadcast studio. The announcer would have sat on one side of the glass panel with the control desk operator on the far side. Photo Nick Catford

One of the most impressive and interesting rooms in the bunker is the radio studio from where important announcements would have been made to the population of the Nordrhein-Westfalia region. Much the same as out own Regional Government Headquarters which all had their own broadcast studios. It consists of a fully equipped and fully operational control cubicle with a separate studio for the microphones. The control cubicle was equipped with a Telefunken six channel control desk with two integrated Telefunken reel-to-reel tape machines. Spools of tape could be played and mixed with announcements from the studio microphone next door. Both the control cubicle and the studio are acoustically treated with perforated metal tiles and a large observation window allows the announcer to be seen by the control desk operator. The studio is equipped with two microphones, main and standby and the red 'on air' lights and cue systems were both working. To see such equipment in perfect condition was a real treat.



Sick bay. Photo Nick Catford

There was also a fully equipped sick bay to deal with any medical emergencies while the bunker was locked down. It had an operating table and equipment to enable any necessary medical procedures to be carried out. Its cupboards would have been stocked with all the drugs and dressings required for a prolonged period.

Having enjoyed free-run of the bunker after our tour, we explored the roof including the aerial arrays and an emergency exit, rather curiously exiting onto the roof of the bunker. We all considered this a rather vulnerable location.

It seems inconceivable to us that this government-in-miniature could have functioned under wartime conditions or, at least, effectively controlled the outside world. The government planned to control the flood of refugees by means of instructions given to civilians – typically police officers and the like – who would have found themselves amongst a deluge of terrified people whose overwhelming aim was in seeking safety. Would the police have been able to control the refugees? Would they even have been able to communicate with Ausweichsitz des Landes Nordrhein-Westfalen to inform them of the position on the ground and obtain effective instructions? Perhaps the citizens of NRW and the refugees that they were planning to welcome were more content to follow directions than their British counterparts.

Our thanks go to our guides Dr Röhling and Herr Kelschenbach for a fascinating and informative tour. Further details of Ausweichsitz des Landes Nordrhein-Westfalen, including visiting times, can be found at http://www.ausweichsitz-nrw.de/PHP/tours.php

Now it's Robin's turn...

Day 3 Emergency 'Seat of Government' Bunker, Marienthal – by Robin Ware

Marienthal, or Ausweichsitz der Verfassungsorgane des Bundes im Krisen und Verteidigungsfall zur Wahrung von deren Funkionstüchtigkeit, as the Germans know it. We would call it the Emergency Seat of the Federal Constitutional Organs in the Event of Crisis or Defence Situations to maintain their Ability to Function. Easier to say than it is to find..... but only just.

The entrance to the Marienthal bunker and museum is located up a very small and winding single-track road surrounded by steep hills and vineyards near the town of Ahrweiler some 35 miles south of Cologne. It was here that we convened at 0900 after a long drive, ready for a visit inside the incredibly important and very large former West German Government Bunker. We were unsure of what we were going to see as there are only very slightly over 200m of tunnel normally accessible to the public.

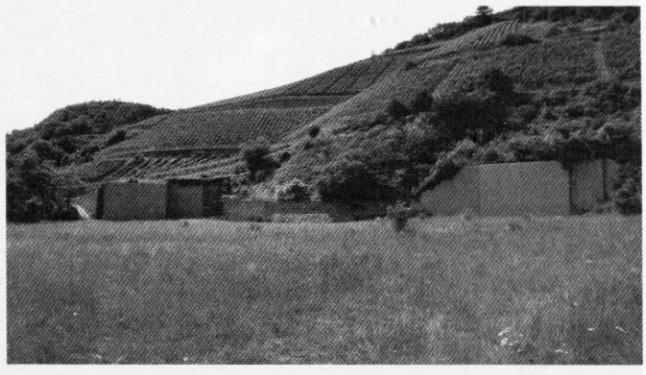
This part has been refitted with various important sections, rooms and set pieces of the former bunker such as the hairdresser's salon, control room, and medical rooms to give an idea of what it contained, though it has to be said that virtually all of the artefacts are somewhat out of context. The 83,000 sq m of original primary working space from the bunker are now represented by less than 2,000 sq m of museum space, or to put it another way, just short of twelve miles of main tunnels, ventilation shafts, escape routes and auxiliary tunnels are now left empty..... very empty.

One of the disused railway tunnels

We entered the Marienthal bunker museum via the documentation centre, with its rusting weathering steel facade and glass windows flanking an original concrete wall. We were given a talk by one of the maintenance men who used to work in the bunker. Here he told us about some of the history of the site.

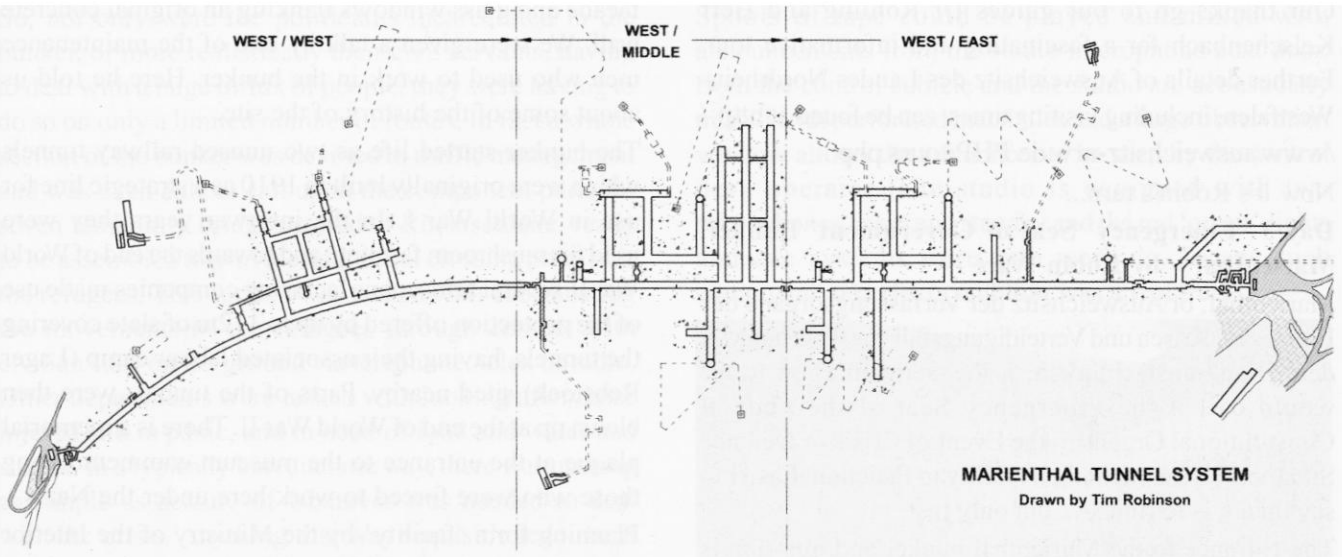
The bunker started life as two unused railway tunnels which were originally built in 1910 as a strategic line for use in World War I. In the interwar years they were used for mushroom farming, and towards the end of World War II several arms manufacturing companies made use of the protection offered by up to 112m of slate covering the tunnels, having their associated labour camp (Lager Rebstock) sited nearby. Parts of the tunnels were then blown up at the end of World War II. There is a memorial plaque at the entrance to the museum commemorating those who were forced to work here under the Nazis.

Planning for a 'facility' by the Ministry of the Interior started as early as 1950, with construction of the Marienthal bunker taking place between 1960 and 1972 at a cost equivalent to just under £2 billion in today's terms. The two tunnel sections were originally separated by a small valley which crossed the rail route, so they were joined up by running a connecting section beneath this valley to give one very long tunnel-cum-bunker. This long, thin structure was then sub-divided into five sections, each section having its own air supply drawn in from bunkered air intakes on the hilltop above. Each of these bunkered air intakes had massive steel and concrete plugs which could be lowered by hydraulic rams at relatively high speed to seal off the air intakes in the event of a nuclear, biological or chemical attack – a slightly slicker approach than the maintenance man hammering wooden plugs into holes in a wall to regulate airflow as favoured by the Brits in Corsham.



Main and service entrances to the now sealed western half of the complex. Photo Robin Ware

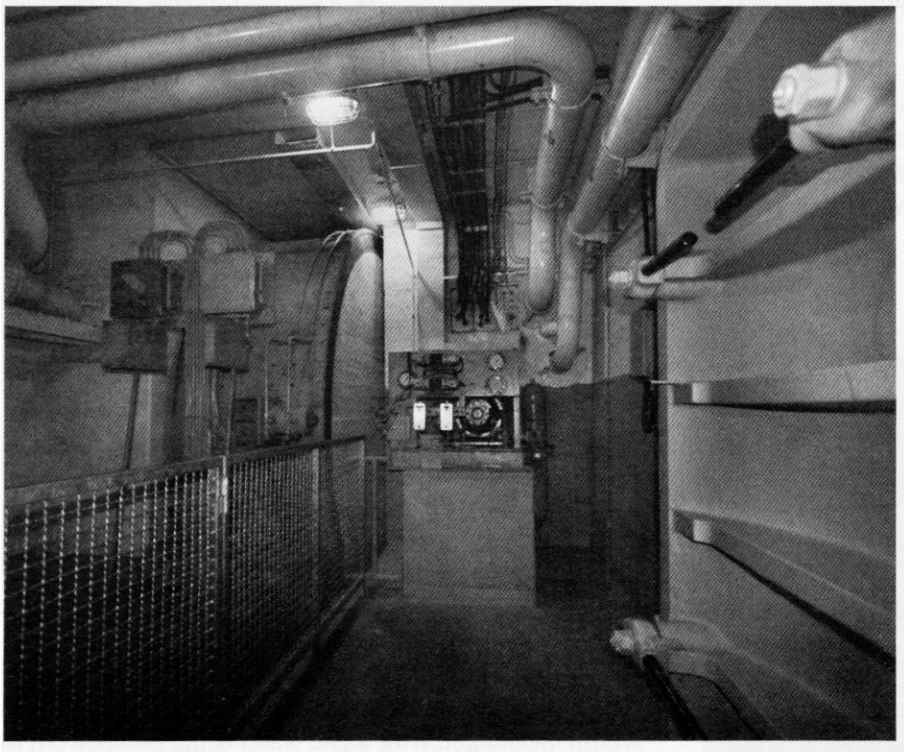
Later we had a wander about on the surface to look at the concrete buildings these air intakes are housed in. Water was, as you'd expect, drawn from wells located within the bunker, with waste water being pumped out to an external collecting pit. All in all, there were 38 access points to the outside world in the bunker complex including the main entrances. Under normal running conditions power would be drawn from the national grid, but when necessary, each bunker section could supply power from its own generators rated at up to 1,250kVA.



MARIENTHAL TUNNEL SYSTEM
Drawn by Tim Robinson

The Federal Government decided to decommission the Marienthal facility in December 1997, and work on stripping out the site started in 2001. The museum and documentation centre was opened in 2008.

Once we had looked around the small documentation centre with its artefacts in glass cases, obligatory bookshop and rather impressive 5m-long plan of the complex cut into a piece of slate hung on the wall, we then passed into the entrance tunnel to the bunker and shortly came across the first proper bit of in-situ bunker evidence.

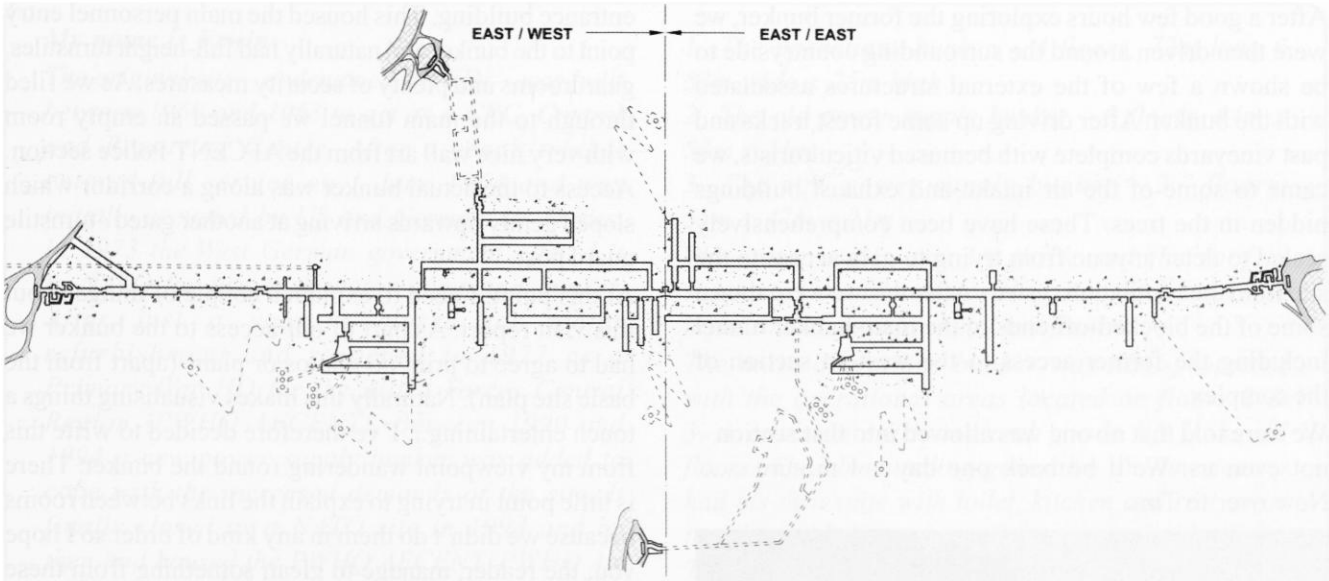


One of two huge circular blast doors which would completely seal the tunnels.
Photo Nick Catford

The front blast door is a substantial round structure which is surrounded by ominous notices saying Danger of Death – Danger of Crushing – Do Not Stand In This Area When Warning Sounds! The guides demonstrated the door for us – a few seconds of red flashing lights and klaxons and the door, resembling a 2.5m-high 25-tonne concrete and steel Rolo, flies across the entrance tunnel at a speed you wouldn't think possible for its size, and seals the tunnel completely. In spite of the fact that there is an airlock bypass, you really feel as though you are either in or out, and any political party candidate who tried to put their foot in the door would be hopping back to the party office. Just for good measure, this blast door set-up is repeated a few yards further along the tunnel and provided a proper airlock facility.

There are decontamination and examination rooms on the other side of the Big Front Door, where anyone coming in would be examined for injuries or contamination – and, if the doctor didn't like the look of you, out you go – or at least you wouldn't be allowed into the main bunker area. Further into the museum we saw the various exhibition rooms: stores, engineering workshops, dormitories, TV studio, offices, dental surgery, kitchen, fire-fighting station, communications equipment, etc.

In one of the recreated offices there was a large magnetic map board on the wall covering everywhere from the Eastern USA right across the Atlantic, Europe and to the furthest reaches of the USSR. To the side of this was a cupboard containing the various magnetic signs that could have been placed on the map – for example JVA, Mittel, TAKT, AWACS, Obj, SGT, 2.op.STFF, Fronten 1, Staffel, TRANSBAIKAL and, to much amusement, a sign for the 'strategische Reserve' was found. It would seem that, in the 1980s and 1990s at



Recreated airlock control room. Photo Robin Ware

least, the strategic reserve was alive and well and living in a cupboard in Germany!

Where the refitted bunker museum comes to an end, the tunnel continues into the hillside. A 20m-long section is occupied by an exhibition covering the decommissioning of Marienthal and also some East German bunkers, and those who have been on previous trips were delighted to see photos of Honecker's bunker Objekt-17/5001, both as we saw it and under construction. Although from the end of this exhibition the tunnel is gated off to prevent your average museum visitor from going any further, it is illuminated by brilliant floodlights, showing just how comprehensive the decommissioning was. Even the paint has been sandblasted off the walls, and all that remains is the odd conduit or two where cables and pipes passed through.

Further examination showed just how much had been stripped out. There were areas where the tunnel had obviously been converted to two storeys but was now hollowed back out to a single empty round tunnel, but with a tell-tale sign of the top part of a frame of a blast door set high up in some remaining concrete at the roof of the tunnel. In other areas the concrete floor has been removed and the void beneath has filled with water. At the furthest end of this eastern section of bunker tunnel there is, apparently, another set of 'Rolo' blast doors rusted in situ, these having last moved under their own power about ten years ago.

Magnetic signs. Photo by Robin Ware

A display area has been created at the end of the museum. The upper level floor has been removed showing the original shape of the former railway tunnel. Behind the photographer a steel grille prevents access to the remainder of the bunker which has been almost completely stripped bare leaving just the railway tunnel and numerous side passages. Photo Nick Catford

After a good few hours exploring the former bunker, we were then driven around the surrounding countryside to be shown a few of the external structures associated with the bunker. After driving up some forest tracks and past vineyards complete with bemused viticulturists, we came to some of the air intake and exhaust buildings hidden in the trees. These have been comprehensively sealed to deter anyone from trying to gain access to the site from the ventilation system. After this we were shown some of the blocked-off ends of the main bunker tunnel including the former access to the western section of the complex.

We were told that no one was allowed into that section – not even us. We'll be back one day – I'm sure..... Now over to Tim.

Sealed entrance of the eastern half of the bunker.
Photo Robin Ware

Day 4 NATO Command Bunker, Börfink – by Tim Robinson

After yet another fine evening spent dining alfresco at the local restaurant we had just one more steamy night to endure (temperature-wise that was). The morning dawned sunny and hot and after the usual excellent breakfast we headed for our last objective of the trip, a major NATO bunker near Börfink. After an uneventful drive we arrived at the site gates where several other cars were unloading familiar faces from the previous days.

Our guide and current site-owner introduced himself and then led us up through the various support buildings and offices to the main surface guardhouse of the bunker. As can be seen from the plan (p. 48) the number of support buildings and site size is always massive compared to the actual bunker!

Here we were told a bit about the site, the bunker, how it operated and what was happening to the place now. In time-honoured tradition here's something prepared by someone earlier (thanks Mike!).

The sun was now pounding down on us so we were pleased to see our guide head across the car park to the entrance building. This housed the main personnel entry point to the bunker and naturally had full-height turnstiles, guardrooms and plenty of security measures. As we filed through to the main tunnel we passed an empty room with very nice wall art from the AFCENT Police section. Access to the actual bunker was along a corridor which sloped gently upwards arriving at another gated / turnstile guard post.

At this point, I need to explain a couple of things about this visit report. As part of our access to the bunker we had to agree to print no photos or plans (apart from the basic site plan). Naturally this makes visualising things a touch entertaining... I've therefore decided to write this from my viewpoint wandering round the bunker. There is little point in trying to explain the links between rooms because we didn't do them in any kind of order so I hope you, the reader, manage to glean something from these words!

Leaving the corridor we found ourselves walking straight into the main operations rooms, a double-height space with observation offices facing a huge map wall. Amazingly some of the maps were still on the wall with some superb markings such as *"Aircraft infringing upon Non-Free Flying Territory may be fired upon without warning"*. Hanging from a simple nail, a blue document labelled *"HQ AAFCE NATO SECRET"* and dated 1979 seemed almost unreal. It was out of reach otherwise I suspect the resulting Sub Brit scrum may have heralded a curtailed tour!

Behind the observation offices was a labyrinth of storerooms and offices. Several still had their names on them such as *"AFCENT NUCLEAR OPERATIONS CELL"* reminding us of the function and seriousness of this place. After some more history and information from our guide and Mike we went into one of the many computer rooms. Nothing spectacular as without kit they become a raised floor / white-walled room but nonetheless we were exploring every nook and cranny searching for evidence of what may have been in there. Back in the corridor we were told that the timber panelling on the wall was not for decorative effect but to reduce the risk of injury from 'spalling', when concrete splinters fly off the walls as a result of the nuclear blast wave. The timber was teak as this has very short fibres and therefore reduces the risk of wood splinters. As far as I could remember I'd not seen this before so added it to the increasing list of eye-glazing facts one can use at dinner parties...

Leaving the first floor we went downstairs past more teak panelling and into one of the filter rooms. The filters were the wheeled variety each with a weight and date painted on – 197 +/- 1kg 1990 –- showing when they were last tested. It was interesting to see that the smoke heads could also detect radiation, sensible we guessed considering any leaks in here would be fatal for the

My name is Erwin

The original site – codenamed ERWIN – was built between 1960 and 1963 to act as a CRC, Control and Reporting Centre. After a year's trial it entered full service on 1 June 1964 and was initially occupied by US and German Air Forces. In 1973 the West German government offered it to NATO for use as a major command bunker. After just a year it closed for major refurbishment and reopened in 1977 as a Primary War HQ for the Allied Forces Central Region (PWHQ AFCENT). Between 1990 and 1994 a new power supply bunker was added to cope with the increased demands of the site. It finally closed as a NATO site in 1994 and by then had housed the PWHQ AFCENT, PWHQ Air Forces Central Region (AIRCENT), the CRC-21 radar site, US Satellite Intelligence Centre and West German Military Intelligence. The Bundeswehr took over ownership after the closure, cleared it of all reuseable kit and put it up for sale.

When the complex was initially built it was only planned for around 250 soldiers; however, almost immediately it was used by up to 350 and so expansion was already required. During exercises this number could increase to 750 and so there was constant change with the surface buildings. The final number totalled ten with another three for the well-head, water and sewage works. The incinerator building, necessary in case documentation had to be destroyed, also doubled as a grill house during the summer months!

The underground complex totals 68,000 sq m and comprises three separate areas (numbered on the plan):

1 The operations bunker – 4 floors, 72m long x 53m wide x 25m high

2 The old power supply bunker – 3 floors, 44m x 53m x 21m

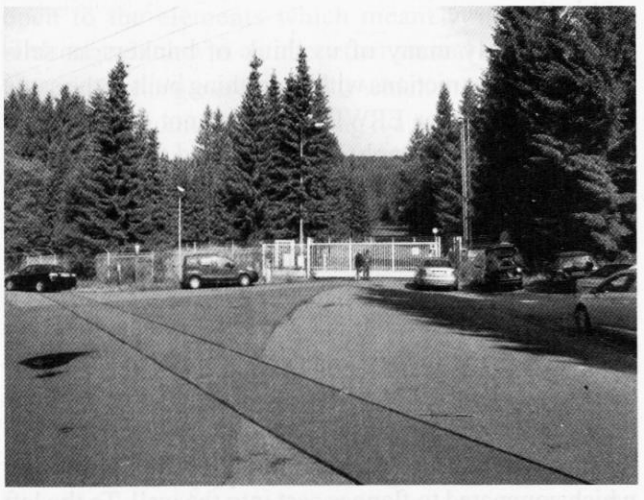
3 The new power supply bunker – 2 ° floors, 55m x 47m x 21m

The outer walls are 3m thick and the roof is supported on I-beams with a 4m-thick concrete layer and then a further 6m of earth.

The main operations bunker was ABC-protected with the operational areas located on floors 2 & 3. A common staircase and goods lift links all floors. The commanding general – an American – had his own suite with toilet, kitchen and rest areas together with his own conference room and offices. These were subsequently reduced in size as later IT equipment was installed that needed less space.

The old power supply bunker housed the original generators for the site. When the new supply bunker was built it was decided on cost grounds to maintain the old generators for the nearby radar site at Erbeskopf (still active under the Bundeswehr). The set-up was impressive with 14 diesel generators each rated at 440kVA and a further six standby sets at 500kVA. There were also four frequency convertors for the U.S. equipment on site as they could not use the standard 50Hz European supply.

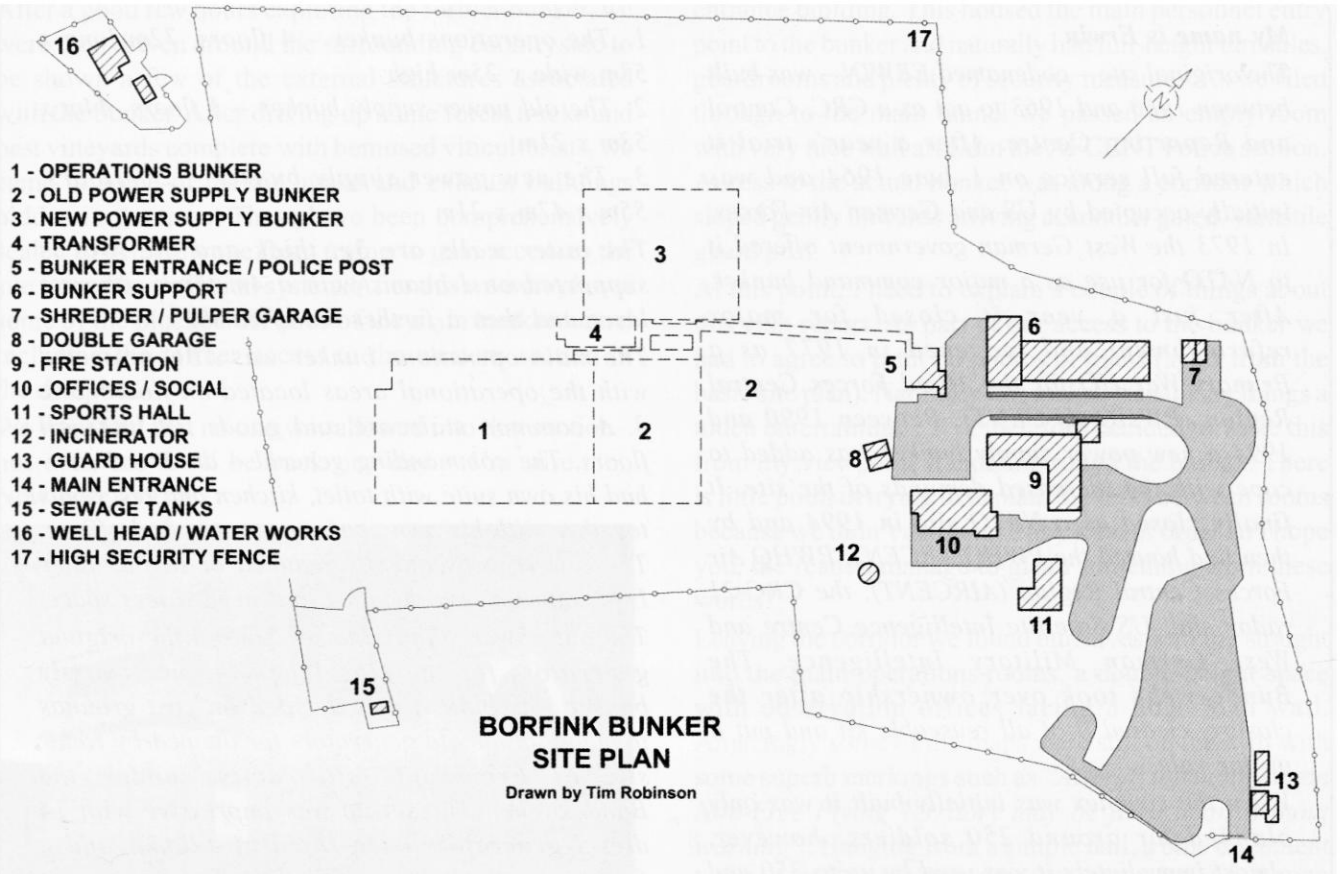
The new power supply bunker was completed in 1994 at a cost of 90m DM / 45m euros. There were four diesel generators each rated at 2,000hp and capable of supplying 1,750kVA. It was critical that in addition to the needs of the NATO bunker, there was sufficient power for the adjacent radar site hence the impression this was just an underground power station!



Entrance to the Börfink complex. Photo Tim Robinson

bunker. A couple of rooms along was the telephone switchboard room. Though the majority of loose furniture had gone, the switchboards were still in place but incredibly so were the handwritten boards giving the phone extensions for both peacetime and war / exercise situations, dated 27 Feb 1991. Such tangible artefacts really brought it home that people in here could have been watching the world, as they knew it, destroyed outside their front gate. It was not hard to work out that nearby would be the MDF room and we were now used to the reaction this brought out in Adrian, our resident phone collector.

A gentle meander through corridors and past offices led us to the first of the a/c plant rooms. Luckily everything was there and we spent quite a time poking about and


1 - OPERATIONS BUNKER
2 - OLD POWER SUPPLY BUNKER
3 - NEW POWER SUPPLY BUNKER
4 - TRANSFORMER
5 - BUNKER ENTRANCE / POLICE POST
6 - BUNKER SUPPORT
7 - SHREDDER / PULPER GARAGE
8 - DOUBLE GARAGE
9 - FIRE STATION
10 - OFFICES / SOCIAL
11 - SPORTS HALL
12 - INCINERATOR
13 - GUARD HOUSE
14 - MAIN ENTRANCE
15 - SEWAGE TANKS
16 - WELL HEAD / WATER WORKS
17 - HIGH SECURITY FENCE
BORFINK BUNKER
SITE PLAN
Drawn by Tim Robinson

getting in each other's way! I found these rooms impressive mainly because everything is painted in such vivid colours. I know this is for practical reasons and not because the interior designers finally got their way but it seems to bring a simplistic contrast to the proceedings.

Back in the corridor we found a working shoe-cleaning panel in the floor, leading into another computer room. This consisted of a rolling set of brushes that you walked over, a very strange sensation to say the least. It seemed weird there was nothing like this for the other computer room as the same issue must have existed i.e. dirty feet = contamination, or maybe the purse strings were at breaking point by then? The computer room was again empty but had a little ante-room with simple timber racking on the wall for posting A4 messages. Each slot was labelled with gems such as *"AIRSTAR / FIGHTER STATUS" and "94TH SAM STAT REP"*. The main a/c filtration control room was fully operational and running, the first thing we had seen actually working. This was huge and had banks of installed and spare filters manufactured in Lubeck. Our guide did his best to explain to Mike the various things in the room and Mike duly relayed this to us all over the din of the machinery!

A longish walk took us out of the warmth of the bunker into a massive hall filled with several generator sets, the total I'm not sure I actually discovered. The painters-by-numbers had been in there too and with a single halogen spotlight at one end and only torchlight to highlight things, the space had a cavern-like feeling to it. Robin was impressed to see the innards of one generator set after it had blown itself apart and I must admit I was too, after he pointed it out. You rarely get to see this apart from on a dedicated cut-away engine.

Next door was the diesel oil tank room, though 'room' is not quite the right descriptive word to use. Think of a three-storey area filled with 29 huge tanks with a central walkway. Paint the tanks bright yellow and have five levels of walkways and you're there. It was as vast as it was claustrophobic and needed the widest of wide-angled lenses to get any kind of decent photo. Each tank held 25,000 litres of diesel oil and the entrance door was several levels up to ensure any leakages would be contained within the space.

I and possibly many of us think of bunkers as self-contained constructions with everything built at the same time. However, for ERWIN this was not the case and the second power supply bunker needed to be linked to the operations bunker. Of course we're not talking a couple of flexible hoses and a jubilee clip here but an entire space dedicated to the task. Not only was this the 'junction box' but it also incorporated a storey height change in level between the various services. Entering the space at the highest point we were faced with the main pipe runs, all stainless steel and big bore. They continued to the right where about 4.5m from the wall the pipe was replaced with stainless steel flexible hosing which connected to flanges cast into the wall. To the left the fixed piping took a gentle fall down to about 3m above

the floor where the same flexible pipes made the junction to the flanges. It was an impressive sight and whilst totally functional would not look out of place in Tate Modern labelled "Bunker Junctions".

It wasn't hard to realise this was a serious set of bunkers and certainly I had thought we'd seen everything by now. We continued the tour, a slightly slower pace having set in quite probably due to the overawed feeling we were all experiencing. Back to regular-sized rooms, we dropped in on the water purification plant which had big, stainless steel tanks on one side and the associated pumping equipment on the other. Control panels, still live, had the usual diagrams showing where the water went to and from around the complex, and maintenance areas still had all their tools and work benches in place. This was lovely to see when we are so used to stripped-out places or even worse, the trashed ones.

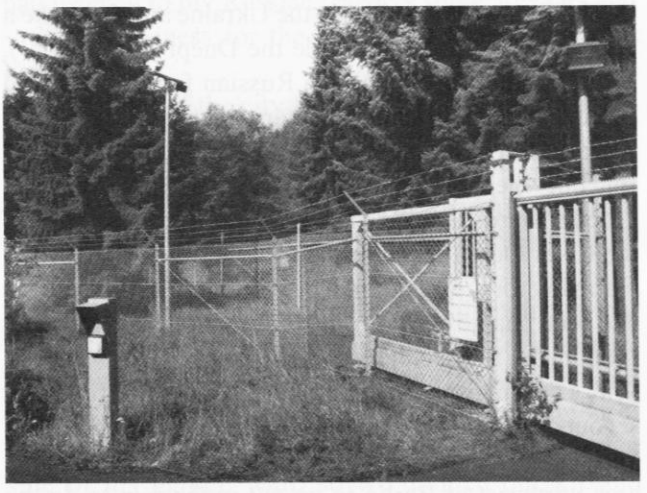
One corridor led to another before we popped out into the fan room and the start of the incoming and exhaust air plant. Three enormous fans sat silently on one side of the room facing a wall of flexible filter panels mounted vertically in two rows. Initially one got the feeling they would be gently fluttering in the breeze as the fans drew fresh air through them but I'm sure in practice it would be a touch draughty in there. What this room did not prepare us for was the start of some truly impressive spaces... We followed each other through a normal sized bright red pressure door and then another which opened into what could only be described as what you may find in the engine room of the *Starship Enterprise*.

It was painted clinically white, featured six or more recessed doorways either side of a three-storey-high, wide corridor leading to a massive five-storey-high intake area. We all agreed that cathedral-like was a reasonable description! The recessed doorways contained fifty round flapper-valves in the back wall which controlled the flow of air to the fan room. Being held open on spring pressure, they would have snapped shut in the event of a nuclear blast. The main intake area was grilled at the top and open to the elements which meant you could hear birdsong which was an altogether surreal experience!

Next stop was generator hall 2 which unlike hall 1 was bathed with sodium light giving it a truly eerie feel. The generators were in pristine condition as was all the aluminium ducting and pipe work, a testament to someone's dedicated work. The last over-sized space was the exhausts for the generators. This was on the scale of the incoming air 'cathedral' with white walls, grilled ceiling and birdsong.

As well as six panels of flapper-valves it had four huge pipes running across the floor, up into what could have been the heat exchangers and then vertically through four similar diameter pipes to the ceiling and out. Again wide-angle lenses were a must for any kind of successful photography. The sheer scale of these last three spaces had brought home to me – and I'm sure others too – the amount of money the Cold War had made countries spend. Only when faced with these structures can one truly take on board the concern, mistrust and in some cases panic that led to these building programmes.

We were now on the last leg of our journey round the complex and after yet another pipe-filled set of rooms we found ourselves in the main control room. This, in contrast to much we had seen, was small with a single bank of desks in front of diagrammatical panels, a couple of TV screens and various indicator boards. As if trying to hang on to the last memories of the bunker's operational days, the TV screen still showed a burnt



Main Gate. Photo Tim Robinson

image of a corridor with grilled doors. After plenty of photography and button pressing we rejoined the corridor that led to the main entrance corridor.

As a parting gift we were all given a small grey box which contained an emergency breathing hood, standard issue to everyone inside the bunker and an attempt to help you get out should the place catch fire. And so we found ourselves back out in the bright sunshine, with a chance for a drink and a quick bite to eat. I took this opportunity to go up the adjacent flight of stairs to see if there was any sign of the buildings covering the air intakes and exhausts. Although they are now very much overgrown, I could make out the two structures through the trees. Amazingly, they were not in any way hardened, just corrugated metal over grilled sides. This seemed a little strange but I guess they knew what they were doing!

Back at the cars, we said our farewells to Mike and the others and made our way back to Hahn airport. With time to spare we took a little detour to show those who'd not been to Hahn before just how much was still left, ripe for exploring! Then it was back to the airport to drop off the hire cars and the traditional end-of-trip meal, beer and chat.

Thanks as always go to Mike for arranging a superb trip covering a completely different side of the story from previous visits to the former East Germany.

Going East

by Mike Barton

I must admit, it took a lot of courage! Since 2001 I've been used to travelling underground in the company of a bunch of undesirables, sometimes more, sometimes fewer. But this time I was going to be on my own.

My psychobabbler had been preparing me for some months, but although the butterflies were on a few training flights, I felt that at my age I should pluck up me courage and venture east to the Ukraine and later – in June – to Moscow.

It had all started with an e-mail from an unknown person in Cherkassy ('go to Kiev in the Ukraine and then take a bus southeastwards alongside the Dnepr for a while'). He had found my name on a Russian forum where I'd been poking my nose into military matters.

Aleksandr, or Sasha as he later became, was trying to find out where his uncle was buried. The uncle had been killed towards the end of WWII during the crossing of the River Oder (the current border between Poland and Germany for the geographically-limited), but the family had been unable to obtain any information from Moscow (you mean, they actually expected to?).

With a few more bits of information, your intrepid explorer set out on this major search. Well, having been an officer, I actually organised a few people who lived in the possible area northeast of Berlin to go out in the rain to do the work for me (old? yes; daft? no!). Within a short space of time, Peter Rentsch (familiar to quite a few of you) had tracked down the cemetery and, lo and behold!, there was actually a gravestone there with the uncle's name on it and not the standard mass grave with no names. Peter took some photos, which I then passed on to the family.

Mission accomplished? Well, not quite. I decided that after 65 years of not knowing where the uncle's grave lay, it was time to do something about it. I made a wreath with contributions from my nearby forest and had a local shop which normally did T-shirt prints produce something sensible for once: viz. a ribbon for the wreath with an inscription in Cyrillic (those funny Russian letters, for anglophiles) with his name and *In eternal memory*. I then drove up to Gross Neuendorf, a tiny little village practically right on the border with Poland, and placed the wreath there with its ribbon and a *pilotka*, the side-hat worn by Russian infantry in those days. More photos for the family...

Even more emotion over there this time, followed by an invitation to visit them. Since this is for SubBrit there has to be an underground aspect somewhere (yes, I know there's the grave itself, but that doesn't count!). Accordingly, I nosed around and discovered the existence of catacombs in Odessa, a city I've always wanted to visit, so I found a suitable time (May), a date – to include the 9th since there was going to be a military parade in Odessa on that day to mark the end of WWII (see below) – and off I went for some ten days.

The flight took me from Frankfurt/Main in Germany via Prague (I was flying with CSA, the Czech airline: very good!) and then on to Kiev-Borispol, familiar to several glowing Chernobyl-lovers from SubBrit. Sasha was there to meet me after the standard queue in front of the passport charmers. He introduced me to Valery, a mate who had had to take a day off work since he was the only one who owned a car, and then outside I also met Ivan, Sasha's father and brother of the fallen uncle.

Ivan, some two years younger than me, but looking some twenty years older from a hard life, greeted me with a huge hug, obviously ignoring the fact that I'm English. Then the tears started: all the emotions which had been built up over the 65 years and the fact that the Second World War and the fallen have a far higher significance in the FSU than perhaps with us were suddenly released. But a very happy Ivan.

We eventually got into the car (which had seen much better times) and set off on a bone-rattling journey to Gelmyazov (just don't ask!), the village where the Andreenko family had always lived and which was to be my home for the next few days.

Ukrainian roads are basically potholes joined together periodically by odd bits of asphalt or building material. Accordingly, it is customary to swerve over to the "wrong" side of the road to avoid dropping down into the deeper potholes; avoiding other, oncoming vehicles is another element in life's little adventure in the Ukraine, as is totally ignoring continuous white lines if it means you avoid a hole. Needless to say, the driver using his mobile while all of this is going on adds to the intrinsic interest for the foreigner sitting rigid in the front seat, feet pressed firmly against a flexible floor.

Since this is basically a family magazine for underground nutters, I will refrain from a lengthy description of life in a Ukrainian village which the world has passed by, save to say that the family was absolutely fantastic, having nothing, but giving whatever they could. I was able to visit two other sisters of Ivan in the same village – tears and bags of emotion from both of them since they could remember their brother, whereas Ivan had been too young to know him personally.

After five days Sasha, Oksana, his wife, and I left Gelmyazov by a reasonably comfortable coach for Cherkassy where I would overnight before going on by train to Odessa. Sasha had very kindly dealt with the logistics side of my trip over there and had purchased a SIM card for my mobile, thus giving me a Ukrainian number as he wanted to phone me regularly in Odessa to make sure that I was OK (not even my ex-wife ever bothered that much!), and also my rail ticket for the

overnight journey to Odessa (seven euros for a ten-hour trip in a sleeper with clean bed-linen, a bit steep, but doable!).

If you're thinking of spending your holidays in Cherkassy, don't! It's rather like parts of East Germany while the Wall was still up, plus the ubiquitous potholes. So, Sasha and Oksana (the Ukraine has definitely some very delightful things to offer!) got me down to the local station on time to board a huge monster of a diesel train, filthy as hell, which was to be my home for the next few hours. Emotional farewells on the platform with promises to a) return and b) to visit me in Germany from the respective parties before I joined my companion in the sleeper, an elderly fellow on his way to a WWII reunion further down the line. Later in the night I learnt (my Ukrainian was by this time improving steadily, having had Ivan jabbering at me practically non-stop) that he was seriously ill with cancer and that both his children were very ill, all cases stemming from a prolonged spell downwind in the garden not far from Chernobyl when it all happened (the population, needless to say, were not warned immediately).

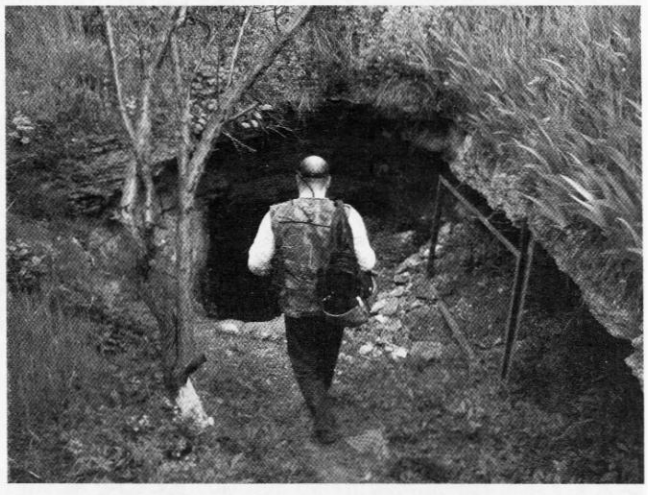
Patience, people, we are getting to the underground bit! I arrived in Odessa at 05.30 and had the impression that they'd all gone on holiday, leaving just a few old ladies cleaning the pavements. Since I fancied that there'd be nothing happening at the hotel for at least a couple of hours, I walked down the wide streets lined with old-fashioned buildings in various states of repair, pulling my suitcase behind me and trying to avoid the pavement's potholes (yes, they have them as well). However, the girl at the hotel was obviously used to early morning arrivals and gave me my key and the option of paying now or later or whenever!

Interestingly, I had booked the hotel from Germany, got an immediate confirmation, no demand for money up-front or credit card details (sorry, Ukraine, no way!), so I was really quite relieved to see the end result: very clean, compact rooms (three metres by four with a loo and shower in a separate room at the end, a TV and a fridge. But no window: a bunker at last!). And all for some 20 euros a night. I crashed out for a couple of hours, only to be woken up by Sasha phoning to ask how I was: fortunately, I know the Russian for "Depart and multiply!", so we were able to arrange for later phone calls in future.

For reasons quoted above, I will refrain from describing Odessa. Suffice to say, it's well worth a visit, particularly if you are interested in photography, old buildings and attractive young Ukrainian ladies (evidently, fast-foods haven't really made much of an inroad so far, so figures are, well, very slim and female). The city is rather like an ageing film star, once very beautiful in her youth, but now the years are telling. However, a considerable part of the city is also very modern and money-based – it all clashes somewhat, rather like having the ageing film star undergoing plastic surgery: it doesn't somehow all fit together.

Prior to my departure I had been in contact with the local expert on the catacombs (yes! we've finally got to the exciting part!). Andrej runs his own website (speleo.od@gmail.com), does the occasional tour, but is involved in several other activities as well. We'd arranged that I'd phone him from my Ukrainian number, whereupon he insisted on coming round that evening to give me a briefing prior to our actual tour on the following day. So, off we went to a nearby café and Sergej spent a good two hours enthusing about the massive holes under the city. He spoke no English, so I was glad yet again that I had listened to my Russian teachers some 50 years ago – thank goodness for the grey cells which were still working!

We drove out of the city the next day in his newish car with its PHAS (pothole avoidance system): this is a bit like any navigation system except that it is based on the driver's eyeballs which never leave the road for an instant. After a while, we turned off onto a side road – well actually, a dirt track much as in the village I'd been staying in – and bumped our way for several kilometres to our destination. This turned out to be a friend's front garden. The friend is a miner in the quarry workings and has not only built his house from bricks cut out from below ground, but he also has an entrance into the catacombs the other side of his garden wall, so we donned our kit and disappeared downwards, the entrances generally being only a gentle slope into the limestone.

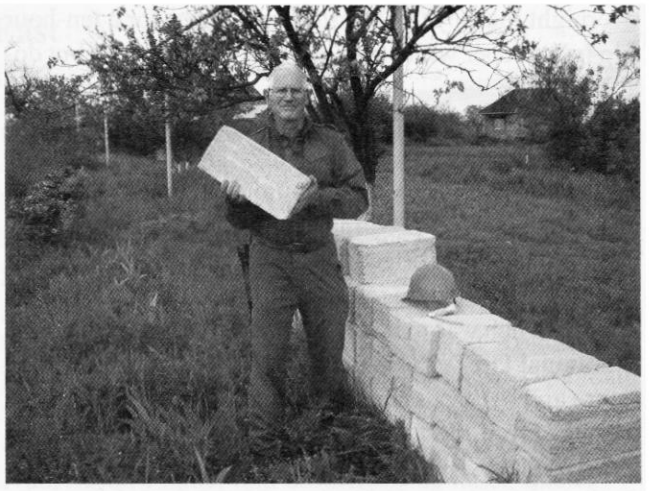


One of the numerous entrances

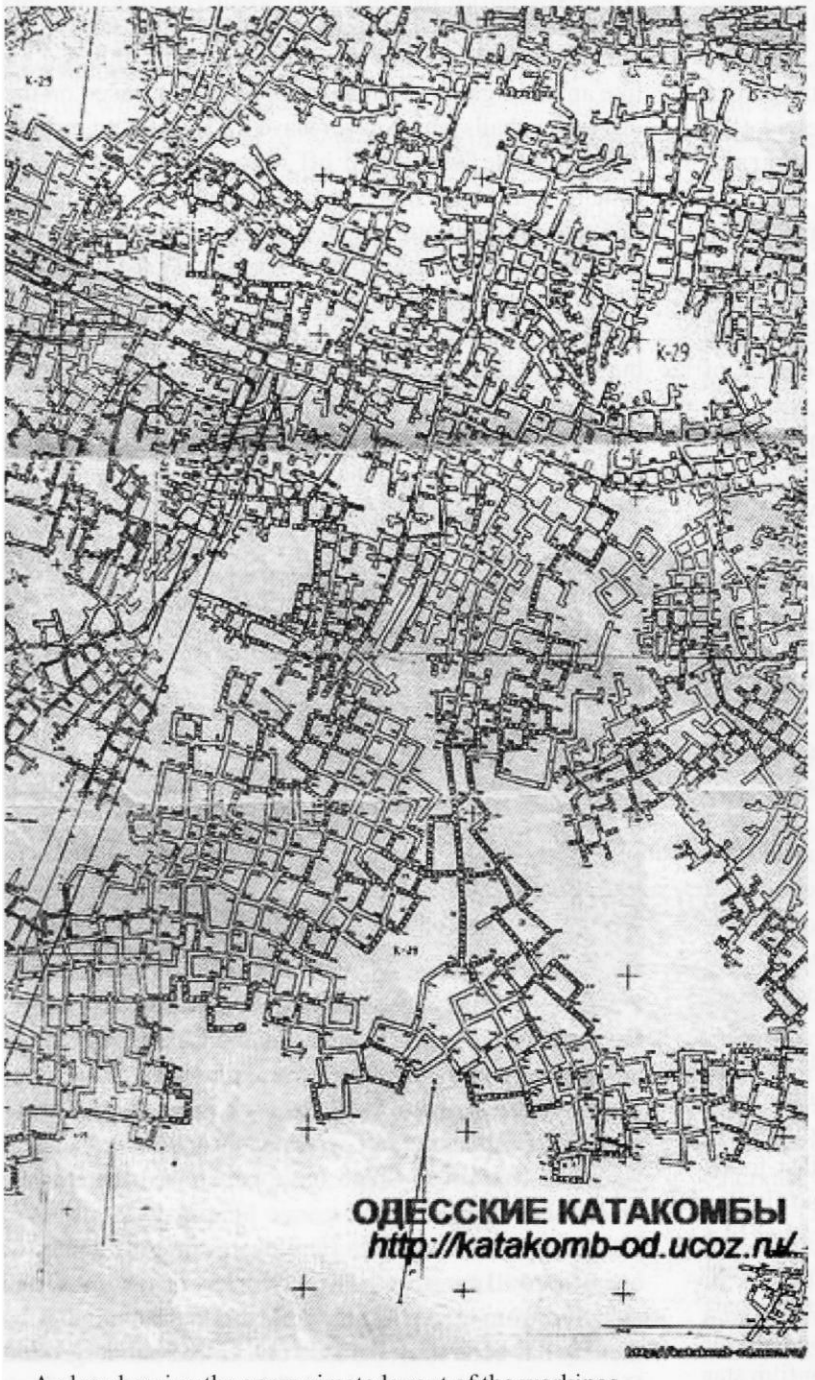
Once inside, you find yourself some five or six metres below the ground and, since the limestone is fairly soft and there are also cracks in the rock formation, it is not unusual to find yourself walking through the hanging "hair" of tree roots which have penetrated the thinner levels of rock.

The city's older buildings (and even some of the newer ones) were all constructed from blocks of shell limestone quarried from beneath their very foundations: in a way, the city has been turned inside out. In fact, underground Odessa stretches way beyond Odessa's surface borders.

A crack in the stone and tree roots



A real brick



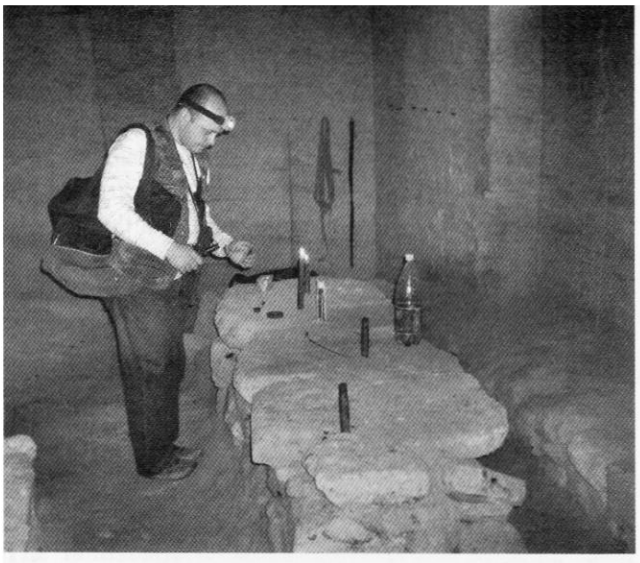
A plan showing the approximate layout of the workings

The greater part of the "catacombs" is the actual quarrying area from which the shell limestone was obtained. Shell limestone is a relatively soft stone, yellowish in colour, which is eventually sawn into blocks of approx. 50 x 20 x 20 cm. The stone blocks were used for construction work in the city until 1960 when they were replaced by the more picturesque concrete slabs and iron girders. Nowadays, the limestone is still quarried but used in the local villages.

Cave exploration is legal in the Ukraine, but obviously at your own risk: there are several documented cases of people who pushed the risk factor too far and perished in the catacombs, to be found months later despite searches organised by the authorities. All you need to do is to find one of the many entrances and in you go! You should note, however, that certain areas of the catacombs are used by junkies and your local alcoholics. Otherwise, you can wander for hours as we did and see and hear no one. In fact, this was the situation during WWII as well: the catacombs were used by the partisans as their base to attack the Romanian soldiers who were up above in occupation.

The partisans were divided into groups and the groups often never bumped into each other for months or even years in the catacombs. At one stage, the Germans tried to gas the partisans, but the tunnelling system is so complex that it was a simple matter for those below to block off one tunnel and disappear down several others. The natural ventilation system is so effective that the gas was soon drawn out.

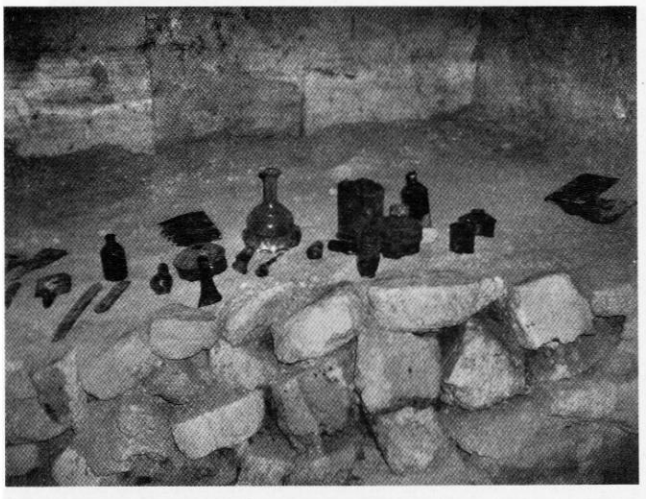
Obviously, the villagers living above the workings tried to continue living their normal lives, but at the same time helped the partisans



Andrej preparing the table for tea

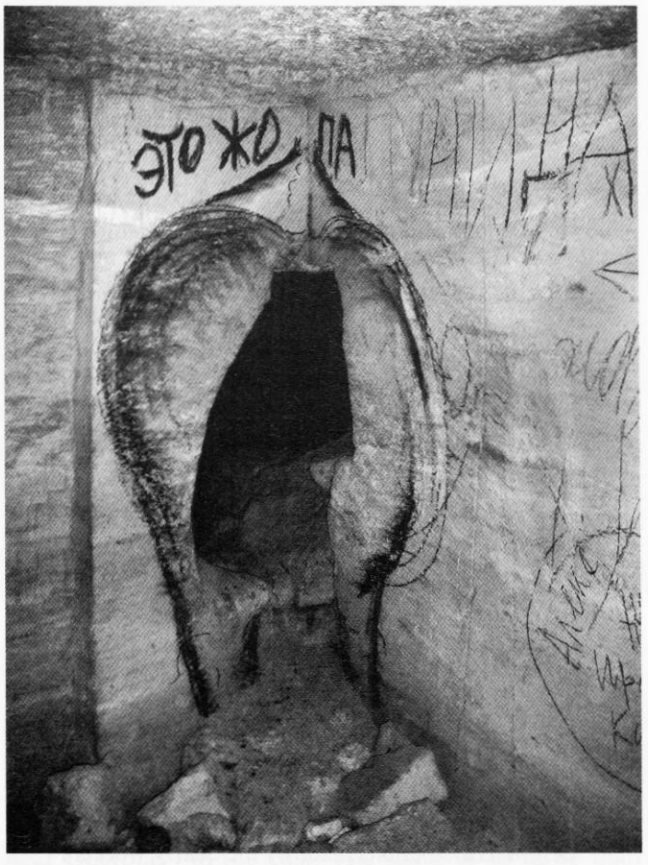
by lowering food in the buckets on the end of ropes which were normally used to collect water from the numerous wells in the village.

Evidence of partisan activity is still to be found today: sleeping areas are dug into the walls at some 40 cm from ground level to raise you from any draughts of cold air, covered with grass and twigs as insulation and there's your bed for the night. Other locations have tables and benches carved out of the stone to serve as dining or rest areas, and there is also a collection displayed on a wall of various artefacts (Fig. 6), ammunition, weapons, etc. found in the catacombs. Humidity, except at the entrances, is fairly low, so rusting or dampness of clothes was not a major problem.



A selection of items found in the quarry workings

As shown in Fig. 3, there is no regular working pattern to the tunnels, so it is VERY easy to get lost below ground. Andrej (an engineer and geologist by training) has been fascinated with the site for over 17 years and does know his way around, which for me was a very good thing as we constantly kept turning off in different directions as he showed me various parts of the tunnels, including two rather oval-shaped holes in the wall which have been given obscene, anatomical names. For some reason, Andrej seemed to assume that I would understand the two terms (thank goodness I'd learnt my dictionary of Russian obscenities!).



An anatomical opening, aka a***hole

During the war a lot of the shafts and tunnels were turned into defensive bunkers and shelters or served as facilities for the NKVD, the then secret police, but they have unfortunately not withstood the passing of time. With the collapse of the Soviet Union, they lost their strategic value and since they were located directly under the city (parts of which had acquired the bad habit of slipping downwards), it was decided to fill in parts of the catacombs.

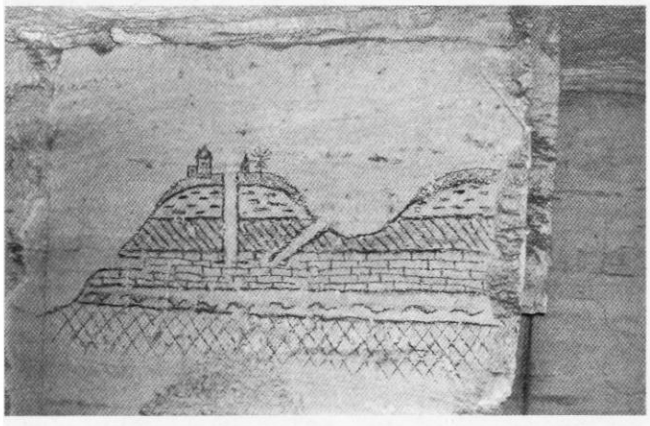
Life for the quarrymen and horses was hard. Horses were used to transport the blocks from the working areas to the surface and the "rails" which were worn into the floor over the years can still be found. Initially, I thought that the horses must have been of the Shetland pony type as we seemed to be bending an awful lot.

Andrej explained that due to the softness of the limestone and the large gaps the roof is gradually being pressed downwards and that broken stone and dirt have also formed a thick surface layer on the floor in places. In fact, in certain areas the roof, or rather very large slabs of it, has broken away and now forms a miniature assault course on the tunnel floor. The local HSE did not, fortunately, appear to be much in evidence. When the quarry was in active use, the spoil was neatly stacked to one side of the tunnels right up to the roof to provide a wee bit more support.

The actual blocks were initially all cut by hand with huge saws (nowadays, mechanical saws are used, but Andrej's friend assured me that he is still exhausted at the end of each working day). The men would make vertical and horizontal cuts into the rock around the "slab" to be removed. This would then be cut or gradually levered away from the mother rock and lowered to the ground on the back of the strongest worker, helped at the end by other workers holding on to the sides of the slab. The slab was then cut into the regulation size blocks. Woe betide any "strongman" who let the slab fall and break into irregular chunks: he lost his month's money and was punished as well.

Original calculations made by the quarry workers

Andrej's two-hour briefing the evening before had been extremely informative and useful preparation for our subsequent tour. He is extremely enthusiastic about his subject, so we finished up with diagrams and sketches all over the table (Fig. 10). He also speaks excellent Russian despite being a Ukrainian, which made a welcome change from the last few days! With the briefing and the tour itself lasting some three hours plus being



A cross-section of the workings used for briefing tours

picked up from my hotel and then taken back I found myself forcing some 200 *hryvnias* (approx. 20 euros) into his hand at the end. He had initially said he'd so enjoyed it (!) he didn't want to charge me, but then said he'd take 100 *hryvnias*.

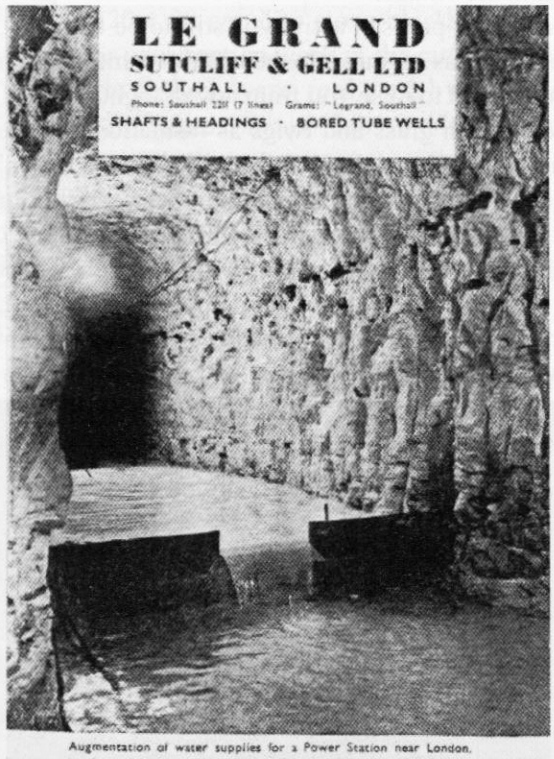
So, there were still two military parades I got to later, but since they weren't underground, who's interested? Incidentally, why do the FSU and its republics celebrate the end of WWII on 9 May? The first signing of the cease-fire took place on the 7th, but the jolly old Soviets at Stalin's urging wanted their own ceremony in Berlin (in the museum at Karlshorst for those of you who have been there). By the time they got round to carrying out the ceremony, it was late in the evening on the 8th and with Moscow time being two hours ahead it was already the 9th in the Kremlin, so the 9th it stayed. Remember: you read it here!

A trip full of unforgettable experiences, fantastically generous people, good living (a full evening three-course meal for some 9 euros – I actually managed 12 on one occasion), lots of sunshine, and I shall be going back – alone!

The Moscow trip will provide an occasion for another load of drivel.

All photos by Mike Barton.

Water Well Adit, London



Augmentation of water supplies for a Power Station near London.
Measuring the flow of water in an adit extension in chalk, 200 ft. below ground surface.

Le Grand, Sutcliff & Gell Ltd of Southall were a leading firm of well-sinkers, responsible as this advertisement implies for dug wells and associated adits, and for bored wells, in and around London. Major public supply wells dug in the chalk under and around London often have horizontal galleries driven from the vertical shaft sideways below the water table, sometimes on more than one level. This such adit, two hundred feet below an unidentified London area power station, is clearly successful in tapping water from water-bearing joints in the rock. The advertisement is from the *Journal of the Institution of Water Engineers* 5(3), advertisement page 28, published in 1951.

Grimebridge Colliery and the Ginnies of Rossendale, Lancashire

by Phil Pritchard

Grimebridge Colliery, sometimes known as 'The Last Working Colliery in Lancashire' is located in the Rossendale area, north of Bacup, and is one of literally hundreds of collieries in that area. The whole area is steeped in coal-mining history; there is also a long tradition of stone quarrying. As well as Grimebridge Colliery itself, the article also describes the 'Ginnies', which were used to transport coal between the pit and the coal staithes, where the coal was distributed. Ginnies were also used on the underground roadways to move the freshly hewn coal from the face to the shaft bottom, or out of the drift.

Geology

The landscape of Rossendale is one of high open moorland, resembling a large, flat-topped plateau, dissected by steep-sided river valleys, which are some several hundreds of feet below. The skyline is generally one of a series of large plateaus, with stepped shoulders. The plateaus consist of horizontal layers of soft clayrock shales which give the shallow slopes, interspaced with the more vertical edges of harder sandstone. The softer rocks have worn away easily, resulting in the stepped outlines. In many locations, the outcrops of hard sandstone have been quarried away.

Coal Seams

The first coal to be mined was taken by simply digging at the outcropping coal seams in the valley sides; this method developing into short horizontal drifts, enabling access to more coal reserves further underground. Next were the simple bell pits, which were shallow shafts down to the coal seam, which were then expanded outwards at the bottom. Looking at contemporary accounts from other mining areas (the Buxton Coalfield, for instance), the spacing of the bell pits in an area was dependent upon the strata, the demand for the coal, the depth of the workings, the effort involved in transporting the coal underground, and the ease of shaft sinking. Essentially, it was down to a question of economics and labour.

The issue of bell pits has been a matter of some debate of late amongst mining historians. There is a view that bell pits of the traditional type are very rare or even non-existent in coal mining. Even in the fourteenth and fifteenth centuries, coal workings in the relatively narrow seams found in much of the UK were being worked well away from shafts, even at shallow depth. Compared to the massive colliery waste tips in the major coalfields, the collieries in this area, especially the smaller and earlier ones, have very little colliery waste evident on the surface. When the only source of labour was manual, it was not efficient to carry waste to the surface, and hence little waste is evident at the sites.

One of the major seams in this area is named the 'Lower Mountain', stretching between the valleys of the River Lumb in the west, and the River Irwell (which starts near Deerplay) to the east. The seam is no more than around 34 inches thick. The collieries that exploited this seam from the Lumb Valley side were the Grimebridge and Nabb Collieries. From the Irwell Valley side they

Grimebridge Tramway

were the Broadclough and Old Clough Collieries. The seam was also taken by Stacksteads Colliery, above Tunstead. Above the 'Lower Mountain' seam is the 'Higher Mountain' seam, which is even shallower at around 22 inches thick.

This relative thinness of the seams made them difficult to work, and it also required extra work to make the roadways underground high enough for tubs, and miners themselves, to pass through. As was typical, the seams were known by many different names.

The driving force for the development of the coalfield was the arrival of cotton mills, which needed power. Initially they used water power, but this was quickly superseded by steam power. One of the first significant collieries opened up was Dean Pit, which supplied coal to the nearby Dean Engine Mill. The next development was Nabb Colliery, which was on the other side of the valley from Dean.

The Hargreaves

By the 1850s, the smaller mining ventures were being closed down and replaced with larger collieries that were able to produce the extra tonnages of coal required by the ever-expanding mills. Financing the sinking of these new mines, and the transport associated with them, required huge investment. In that era, there was still a significant element of gambling and financial risk involved, the results not being guaranteed. This financing was beyond the means of the local entrepreneurs, so the gap was filled by the Hargreaves Colliery Company.

Henry Blackmore sank a small shaft at Fulledge around 1720, which proved to be troublesome. After his death in 1754, his widow married the Reverend John Hargreaves, who started what was eventually to become the Hargreaves Colliery Company. In 1797 he purchased the leases of almost all of the mineral rights in the Burnley area. Reverend John Hargreaves died in 1812, and left his estates to his brother's children, James and John Hargreaves. John was a JP, and Deputy Lieutenant and High Sheriff of the County of Lancashire. In 1802, Colonel John Hargreaves married Charlotte Ann Ormerod, and gained the Ormerod Estates where they lived in Ormerod House. Further coal mines passed to Colonel John Hargreaves on the death of his brother James.

The couple had three children. The first was Eleanor Mary (1803–83), who married the Reverend William Thursby; the second was John (1804–26), who died young. The third was Charlotte Ann (1805–88), who married James Yorke Scarlett, and she died without having any children. The marriage of Eleanor to the Reverend Thursby resulted in the Hargreaves Collieries passing into the hands of the Thursby family. When Colonel John Hargreaves died in 1834, the Hargreaves Collieries were named 'The Executors of John Hargreaves Collieries Company', known as 'The Exors of John Hargreaves Collieries Company', later to become the plain 'Hargreaves Colliery Company'. This company dominated coal mining in the area until nationalisation in 1947.

In the mid-19th century, the Hargreaves Colliery Company was associated with the following collieries:

- Whitwell Bottoms, Newchurch, Rossendale – Hargreaves, Ashworth and Co.
- Swinshaw, Newchurch, Rossendale – Hargreaves, Ashworth and Co.
- Padiham, Padiham – Exors of the Late John Hargreaves
- Old Clough, Newchurch, Rossendale – Hargreaves, Ashworth and Co.
- Old Hey, Brandwood, Bacup – Townsend, Hargreaves, and Barlow
- Old Meadows, Bacup – Hargreaves, Ashworth and Co.
- Old Sink, Rowley Moor, Brandwood – Townsend, Hargreaves, and Barlow
- Marsden, Marsden – Exors of the Late John Hargreaves
- Hapton Valley, Hapton – Exors of the Late John Hargreaves
- Greave, Brandwood, Bacup – Townsend, Hargreaves, Barlow
- Habergham, Habergham, Burnley – Exors of the Late John Hargreaves
- Dean, Newchurch in Rossendale – Hargreaves, Ashworth and Co.
- Coppull, Coppull – John Hargreaves junior
- Brex, Newchurch,Rossendale – Hargreaves, Ashworth and Co.
- Baxenden, Baxenden – Hargreaves, Ashworth and Co.
- Burnley Drift, Burnley – Exors of the Late John Hargreaves
- Burnt Hills, Clowbridge – Exors of the Late John Hargreaves

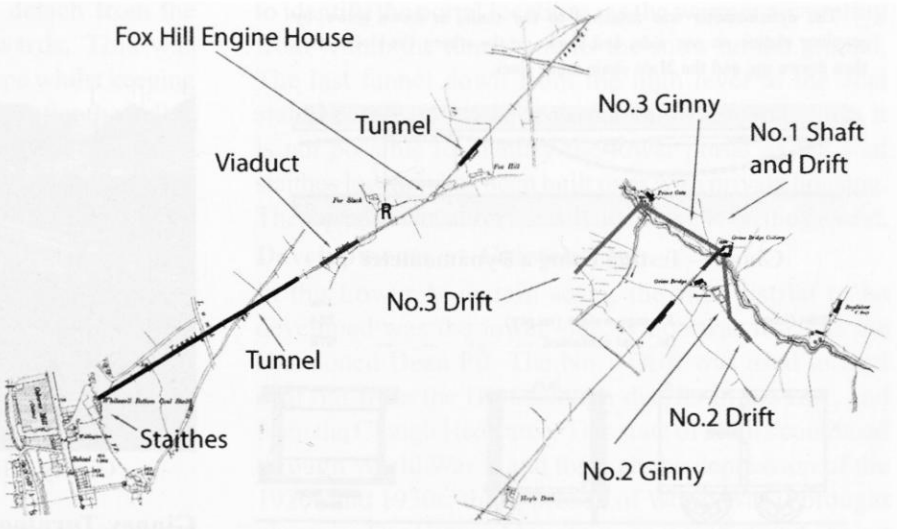
Grimebridge Colliery

As other mills were built, the demand for coal increased, and it was obvious that a colliery was needed to exploit the reserves between the two valleys. The Grimebridge No. 1 Shaft was sunk in 1851, and was 96 feet deep. At around the same time, a surface drift (Grimebridge No.1 Drift) was also driven at a steep gradient down into the Lower Mountain seam. There were underground roadways driven south through a fault line to connect into Stacksteads Colliery, and another roadway driven west towards Broadclough, where it broke surface. This roadway was used for ventilation, and as a walking route for the colliers to travel to work from the Bacup and Irwell valley area. The colliery, like many others in the area, was owned by George Hargreaves and Company. The workings at Grimebridge were extensive, and a close examination of the abandonment plans overlaid on modern

Ordnance Survey mapping shows that the workings extended to almost the whole area of Smallshaw Heights underground, and closely followed the contours of the hill at their limits. In some places, the galleries and roadways broke surface. The Smallshaw Height trig point is at 1,341 feet altitude.

Ginnies

Grimebridge Colliery was soon winding over a thousand tubs of coal per day, and with additional tubs coming up the drift, a transport method was needed to deliver the coal to the coal staithes in the valley bottom. The method used was known locally as a "Ginney", which was a tramway, driven by an endless chain which pulled the tubs of coal along at a walking pace.



Grimebridge Tramway - from Grimebridge to the Staithes at Whitwell Bottom

The main extent of Grimebridge tramway was on the level across the moors, until it reached (what was at the time) Fox Hill Colliery, where a slight change in direction and inclination was required to get it down to the coal staithes at street level in the valley bottom. There was an engine house near Fox Hill, at the western end of the high level section, with another short level section leading to a self-acting incline in a steeply inclined tunnel down to the coal staithes in Whitwell Bottom. The engine house at Fox Hill is still in existence.

Remains of the Fox Hill engine house

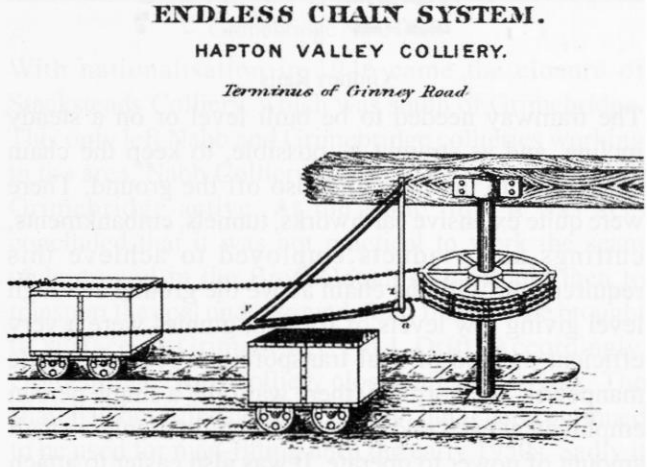
The surface ginnies often extended for several miles, and sometimes tunnelled underground for considerable distances. They were (usually) straight, and on a flat plane; however, the plane did not have to be horizontal. The tramway system using the chain for haulage could not cope with undulations, as the driving chain would simply lift the driving fork out of the notches on the tubs. Some of the higher level sections of the Grimebridge tramway were in very shallow tunnels, which were probably constructed using traditional cut-and-cover methods. These tunnels also afforded some protection against drifting snow in winter. Ginnies were also used underground within the collieries themselves.

Grimebridge Tramway

As already stated, the power for the higher level sections of the ginnies came from steam engines; whereas the last section down to the Whitwell Bottom staithes was worked as a self-acting incline with the loaded tubs going downhill pulling the empty tubs back up to the level section. There is an extract in Volume 17 (1867–68) of the Transactions of The North of England Institute of Mining and Mechanical Engineers that details the calculations involved in determining the power of the steam engine required. It also details the trials using a dynamometer that led to the calculations. The article mentions other collieries which were in the ownership of the George Hargreaves Company.

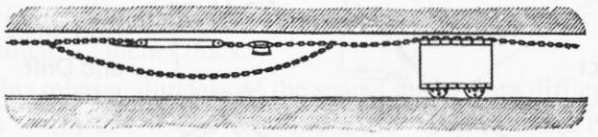
Haulage

The tubs (wagons) used on the ginnies were four-wheeled; they had flangeless wheels that ran in sections of angle iron rail, fastened to wooden sleepers with spikes. The haulage system was very simple. There was a continuous chain, maintained under tension, approximately at waist height. The tubs were attached to the moving chain at intervals of between 30 and 120 feet, and by



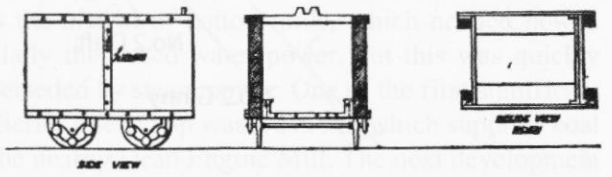
Ginney - Driving System (actually as used at nearby Hapton Colliery)

The dynamometer was attached to the chain, as shown below, by coupling chains on one side, and blocks on the other; the blocks were then drawn up, and the Main chain made slack.



Ginney – Testing Using a Dynamometer

		Lbs.
Tubs (iron)... ...	Average weight (empty)	364
	Do., coal contained	672



DIMENSIONS OF TUBS.

	Ft.	In.
Length inside...	3	1½
Breadth	2	4
Depth	1	11
Height above rails	2	8
Distance coupled	1	11½
Diameter of wheels	0	10¾

Total number on ginney road	166
Number required to work ginney road	172

Ginney - Coal Tubs and Rails (as used at nearby Hapton Colliery)

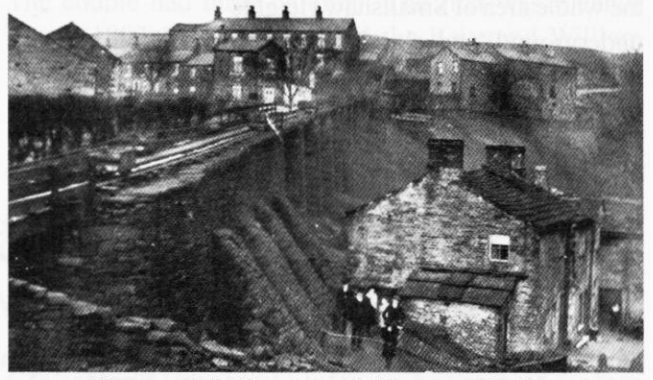
simply letting the chain links engage into raised notches on the top of the tub ends, the tubs were pulled along inside the flanged rails at a walking pace. This was a particularly dangerous haulage system when operating, especially regarding the hooking on and off of the tubs. Ginnies also served as an obstacle for the general population in their normal travels in the area. There were numerous accidents, with workers and the public losing limbs, being hit by the tubs, including fatalities. There were few physically constructed crossings of the tramways; fortunately the tramways were often underground.

RAILS.

	Lbs.
Weight per yard	28
	Ft.
Length of each	6

Ginney Rails

The tramway needed to be built level or on a steady incline, and as straight as possible, to keep the chain engaged onto the tubs, and also off the ground. There were quite extensive earthworks, tunnels, embankments, cuttings and viaducts employed to achieve this requirement. With the chain above the ground at a high level giving low levels of friction, ginnies were a very efficient method of coal transportation requiring little manpower, and normally there was only a single person employed at each end. They also required only a small amount of power to operate. It was also easier to attach and detach the tubs with the chain at a higher level, and it also reduced wear on the chain.

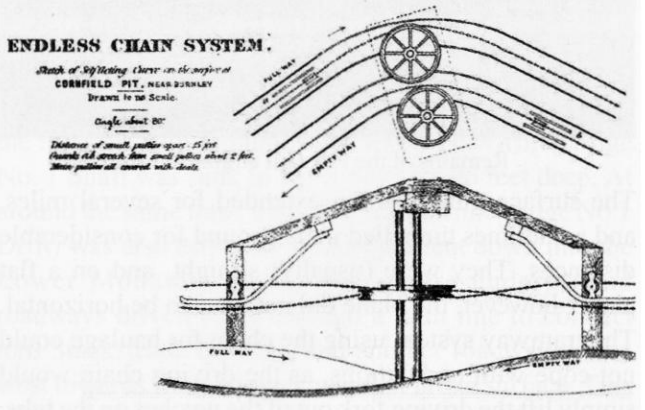


Ginney - Hile (Stacksteads) Tramway Viaduct

Ginney Turning Points

Although not used on the Grimebridge tramway, it was possible to have a turning point on a single section of tramway to change the direction of the tramway; the two well-known examples still in existence are on the Cornfield Colliery tramway, located just a few miles north towards Burnley. The turning points were essentially two

Ginney - Turning Point on Cornfield Colliery (nr Burnley) Tramway



stone-wall constructions, with the appropriate angle required for the change of direction built into them, and with a mechanical pulley wheel arrangement between the two stone walls to guide the haulage chain above the ground. The use of a pulley for changing the direction of

the chain meant that the tubs had to detach from the chain before it and re-attach afterwards. This was achieved by running the rails down a slope whilst keeping the chain level. The chain then descended after the pulley and this allowed the tubs, now on a level track, to be re-attached.

Viaducts and Tunnels

The Grimebridge tramway had two viaducts; the stone piers of both still exist. One was a short viaduct as the tramway left the Grimebridge No.1 pithead, and another longer one was in the middle where the tramway crosses a shallow ground depression.

Grimebridge Tramway - Middle Viaduct Piers

The tunnels were more numerous, there being several along the length of the Grimebridge tramway. They also served a secondary task of keeping the higher levels sheltered from snow, which would have been a problem in the winter, especially as the demand for coal would increase during colder weather. The tunnels at the higher level were not very deep underground, suggesting that they were constructed by traditional cut-and-cover method. They were around four feet high at the crown, with what appears to be a stone arch construction, and a flat floor. They were not more than about four feet wide, which would have made repairs, maintenance and fixing derailments difficult.

Grimebridge Tramway - Ginney Tunnel entrance

The tunnels on the higher levels still survive, with the portals simply pushed in and overgrown. However, on a cold and frosty day, with snow on the ground, it is easy to identify the portal locations, as the warmer air venting from within the tunnels melts the snow on the ground. The last tunnel down from the high level to the coal staithes at street level operated at quite a steep incline, it is not possible to identify the lower portal as the coal staithes location has been built over with private housing. The top portal location is easily identifiable on the ground.

Developments at Grimebridge

In the Lower Mountain seam, the first district to be developed was the lower side, which was towards the abandoned Dean Pit. The No.1 Drift was used to haul coal out from the Broadclough district in the east, and from the Clough Head area. This state of affairs continued through World War I, and through the depression of the 1920s and 1930s; the approach of World War II brought changes. The Higher Mountain seam was already being worked from Stacksteads Top Colliery in the south; in addition, Grimebridge No.2 Drift was driven into the Higher Mountain seam from a location southeast of No.1 Shaft, with a surface ginney crossing underneath the road to Grimebridge Farm (which incidentally now uses Drift No.2 as a water supply). Further east up Hebb Clough, a small shelter was built, with two other drifts opposite it; one was a brick arched walking route, and the other was for coal.

Grimebridge No.2 Drift

With nationalisation in 1946 came the closure of Stacksteads Colliery, which was south of Grimebridge. This only left Nabb and Grimebridge collieries working in the area. Nabb Colliery closed in 1954, leaving only Grimebridge active. At the same time it was also concluded that it was not practical to work the seam underground in the Broadclough district, and then to transport the coal underground, for it finally to be brought to surface at Grimebridge No.1 Drift. Accordingly, Grimebridge No.1 Colliery closed after 104 years. The shaft had not lifted coal since 1929, but it had continued to be used for man-riding until the early 1950s. Sadly it was filled with the rubble of the demolished surface workings and buildings.

Grimebridge No.3 Drift (Griffs)

Southwest of Grimebridge No.1, a new drift was driven, No.3 Drift, always known locally as 'Griff's Rough', after the landowner. This was to exploit coal in the Lower Mountain seam towards the old Fox Hill area. A new surface ginney was constructed from No.3 Drift, turning sharply at Princes Farm to pass by the site of the old No.1 shaft, and then down into No.1 Drift, then along the recently enlarged old travelling road, for the coal to emerge at Broadclough into a new surface plant.

Modernisation also appeared underground, with compressed air picks slowly replacing the manual picks, much to the chagrin of some miners. No.3 workings were very close to the surface, making it a very wet pit – it also holed out into fields at a number of locations.

By 1960, the end was in sight as the coal reserves started to run out. Griff's Rough (Grimebridge No. 3) closed in 1962, Broadclough Colliery in 1964. The men were constantly moving around the pits as they closed, the last colliery to close being Old Meadows in 1969.

Grimebridge – Post-Official Closure and Final Years

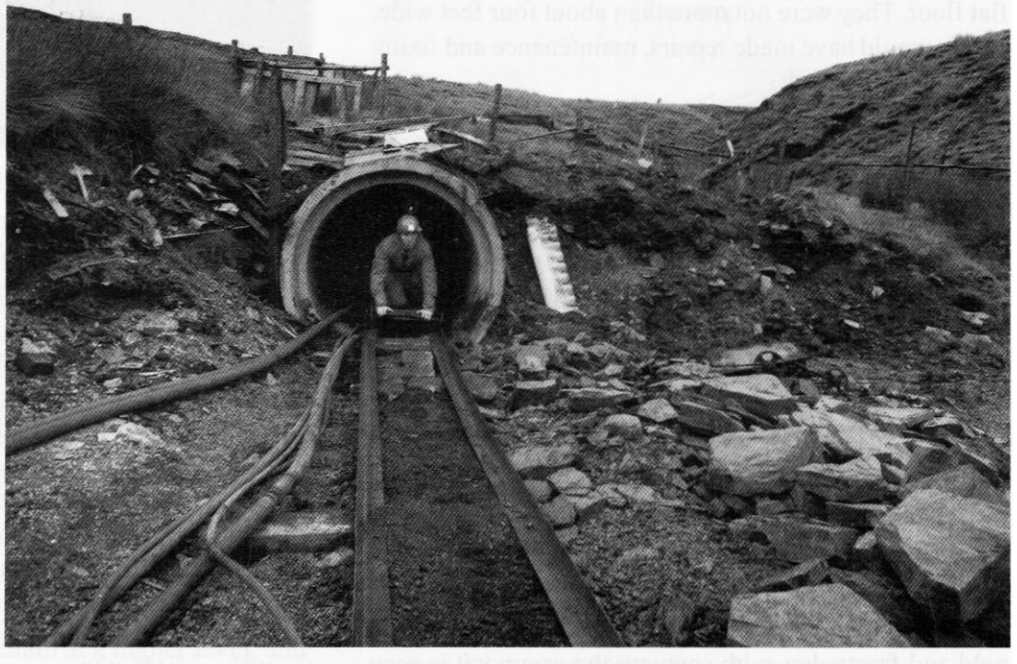
The story of Grimebridge Colliery takes a new and different turn after the 'official' closure. The long established Clayton mining family figure prominently in the story.

James Clayton had three sons, Billy, Robert and George. After closure, they went different ways. While he was working at several other local collieries, Billy Clayton applied for a licence to work coal at two locations. One application was to work part of the (closed) Stacksteads Colliery, and the other to reopen the Higher Mountain seam at Grimebridge. Finally, in 1978, he gained the licence to reopen at Grimebridge. With some difficulty, the drift to the east of the old travelling (walking) road was cleared, and coal production began, with the new pit based around the old cabin at Smallshaw.

When production began, the workforce was steadily increased. In 1979, a new surface drift was driven into coal left behind by the NCB, but it had to be driven for over 200 yards before there was enough cover (60 feet) to the surface above the workings. The workforce grew to over 30 employees, including a certificated colliery manager. The coal was sold either to the Ribble Cement Works at Clitheroe or to Padiham Power Station. They also expanded by buying Tan Lan Colliery (near Coed Talon, North Wales), which eventually proved to be a failure, the ex-Grimebridge men working there being pulled back to Grimebridge.

The Final Years

There were problems on the horizon, as contracts ended and the price paid for the coal fell. The remaining workers and manager left Grimebridge Colliery. One of them, studied at college to be a certified Deputy, and the coal production continued at a low rate. On 31 May 1990, Grimebridge closed. After some months, Billy Clayton reopened the colliery again and production restarted; the price for coal had improved after some legal arguments in the European Court. With some six men employed, Grimebridge closed for good on 4 July 1996, and the drifts were pulled some five days later.



Grimebridge Top Bed drift in September 1995. Photo Nick Catford

There was a light interlude during the final years. One episode (named *Backtrack*) of Series 4 of the once popular TV series *Juliet Bravo* was filmed with scenes in a coal mine. The drift used for the filming was one of the Clayton-era Grimebridge drifts at Smallshaw. The programme was first broadcast on Saturday 3 December 1983. Sadly, your author bought a DVD boxed set on eBay to view the episode!

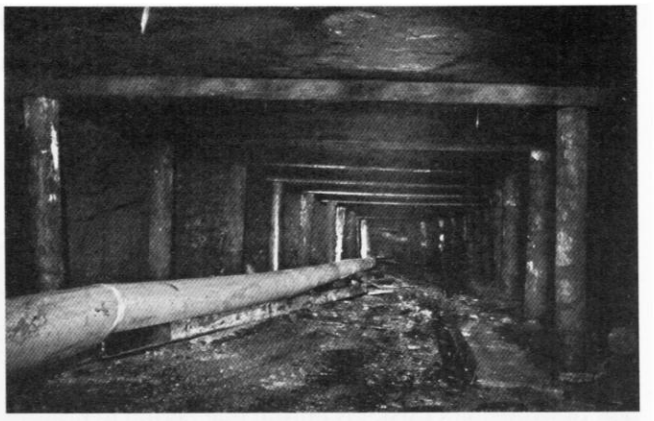
Grimebridge – The Story Continues at Hill Top

That was not the end though; it was the end of Grimebridge Colliery, but not of the Claytons. After a year, the Grimebridge Colliery Co. Ltd. obtained a licence to start a new colliery at Hill Top, driving two new drifts into the 4 foot 6 inch thick Union seam, between the old NCB Hill Top Colliery and the open cast on Heald Moor.

Hill Top drift entrance

The coal is exceptionally hard, and contains nodules (known by various names, including "coal balls", "Burnley Bobbers" or "Bullions") which are harder than the coal, and quickly blunt and damage any tools used, which is one reason that the NCB gave up at Hill Top. Because of the hardness, it is difficult to get an economic quantity of coal out in a shift, giving poor profit margins.

The coal balls often contain fossils, and are sought-after by geologists. As an aside, Hill Top was once visited by



Hill Top - Inside the Drift

Marie Stopes, better known for her pioneering work on birth control, to collect fossils. She was the Lecturer in Palaeobotany at the University of Manchester from 1904 to 1907, and studied coal and the collection of Glossopteris (ancient seed ferns).

Sadly, William (Billy) Clayton, the owner of Hilltop and Grimebridge Collieries, died at Burnley General Hospital on 16 June 2008. His son has continued to operate the Hilltop mine, and even now is now looking to the future.

All recent pictures by Phil Pritchard, unless stated.

References

Grimebridge Colliery was visited on several occasions with David Kitching and Simon Hirst during 2009 and 2010.

i) Northern Mines Research Society publication "The Coal Mines of East Lancashire", British Mining No.58.

ii) Northern Mines Research Society publication "Memoirs 1997", British Mining No.59.

iii) "History of the Forest of Rossendale, With a Chapter on the Geology of Rossendale", Thomas Newbigging, Pub. 1868.

iv) Volume 17 of the Transactions of "The North of England Institute of Mining and Mechanical Engineers", 1867-1868, Google Books

v) Website: *www.bacuptimes.co.uk*

Subterranea Britannica TREASURER

Sue Monsell has decided to stand down as Treasurer after many years of valuable service to Sub Brit. As a result we are looking for someone to take over the role. If you think you'd be able to spare some time to undertake this important function, then please email info@subbrit.org.uk or write to Sue at our registered address.

Empire Jack (John Norton Griffiths), tunneller and arsonist, of Betchworth, Surrey

by Paul W. Sowan

Nobody looking today at Wonham Manor, Betchworth, near Reigate, would suspect the colourful life led by its occupant from 1918 to 1930, Sir John Norton-Griffiths [1871 – 1930], otherwise known as Empire Jack, or indeed his dramatic death (probable suicide) off the coast of Egypt. Griffiths had charge of sewer tunnelling works in Manchester and London, construction works world-wide, military tunnelling on the front line in Belgium and France during World War I, and the destruction of a large part of Romania's oilfields during that period to prevent them falling into enemy hands.

Norton-Griffiths (he hyphenated his name on being made a baronet in 1922) was the son of an itinerant clerk of works engaged in major building works around the west country and in London and the southeast. He was born John Norton Griffiths at West Quantoxhead (Somerset) on 13 July 1871. Although his father intended a career in architecture for him, he performed indifferently at school, where only the games field appealed to him. He was caned frequently! He deserted his junior draughtsman post at a firm of architects and, lying about his age, enlisted as a trooper in the Royal Horse Guards. But an even more adventurous life was his wish and, buying himself out of the Army within a year, and assisted by a friend, he set off (aged 17) for South Africa, where sheep rearing led to gold prospecting, gold mining, and railway construction. And an active part in military action, and the Second Boer War of 1899 onwards. Somehow, from all these activities, he accumulated sufficient wealth to set up in business as a building and public works contractor, taking responsibility for construction projects worldwide. This work included driving new sewer tunnels under Manchester. In 1908 he had oversight of the Battersea to Deptford main drainage construction, and in 1911 he was concerned with the City & South London Railway extension.

Although primarily a businessman, not an engineer, his practical experience in Africa, and his hand-on approach in general, stood him in good stead during World War I. Germany had introduced military tunnelling on the western front, allowing them to explode mines under the British line. Lord Kitchener (Horatio Herbert Kitchener [1850 – 1916]), who had become Secretary of State for War in 1914, was persuaded by Griffiths to establish British and Empire tunnelling companies whose task was, similarly, to undermine and create havoc in the German front line. Several books tell the story of the incredible Griffiths driving up and down the British side in a Rolls Royce car, dispensing cases of champagne or port to persuade senior officers in the field to co-operate with his unorthodox tunnelling missions. These led to the massive eruptions under the enemy lines at, amongst other places, Hill 60, and the Messines ridge. Derelict and semi-collapsed tunnels, and huge craters, remain as a memorial to his efforts in Flanders, as do (reputedly) some still unexploded mines! His innovative (and unsuccessful)

tunnel-boring machines, invented for these purposes, were trialled at the War Office Testing Ground at Claygate.

In the latter part of the War, Griffiths was assigned the task, more or less single-handed, of sabotaging the Romanian oilfields (and destroying food stocks) before the advancing German Army could benefit from them. He destroyed an estimated 165 million gallons of oil, throughout 1,000 square kilometres of Romanian territory. How, or if, the original owners were to be compensated was much haggled about after the war!

On Armistice Day (11 November 1918) Griffiths and his wife Gwladys signed the deeds for Wonham Manor, near Betchworth. He had, since the General Election of January 1910, been (alongside his other activities!), the Conservative Party's MP for Wednesbury (Staffordshire). But from 1918 he served as the member for Wandsworth. His political campaigning style earned him the nickname Empire Jack. He was instrumental, with others, in founding what we know today as the Royal British Legion. So the Legion's premises up and down the land, and the November poppies, serve as another memorial to him. He was made a baronet in 1922.

Civil construction projects again took his attention: he was at heart, a construction man, despite having been responsible for so much destruction during the war. He became involved in the 1928 scheme to heighten the Aswan dam in Egypt, at which point his good fortune deserted him. Funds ran out. On the morning of 27 September 1930 he rowed out into the Mediterranean, as it was his wont to have a swim each morning at this time, from his quarters at the Casino Hotel, San Stefano, near Alexandria. And disappeared. Shortly afterwards his body was retrieved, with a head wound, but no sign of a gun. Suicide seemed most probable, although suggestions of assassination (perhaps by Romanian interests) also circulated. Sir John Norton-Griffiths was buried at Mickleham Church (Surrey) on 18 October 1930. His widow survived him until her death (aged 101) in 1974.

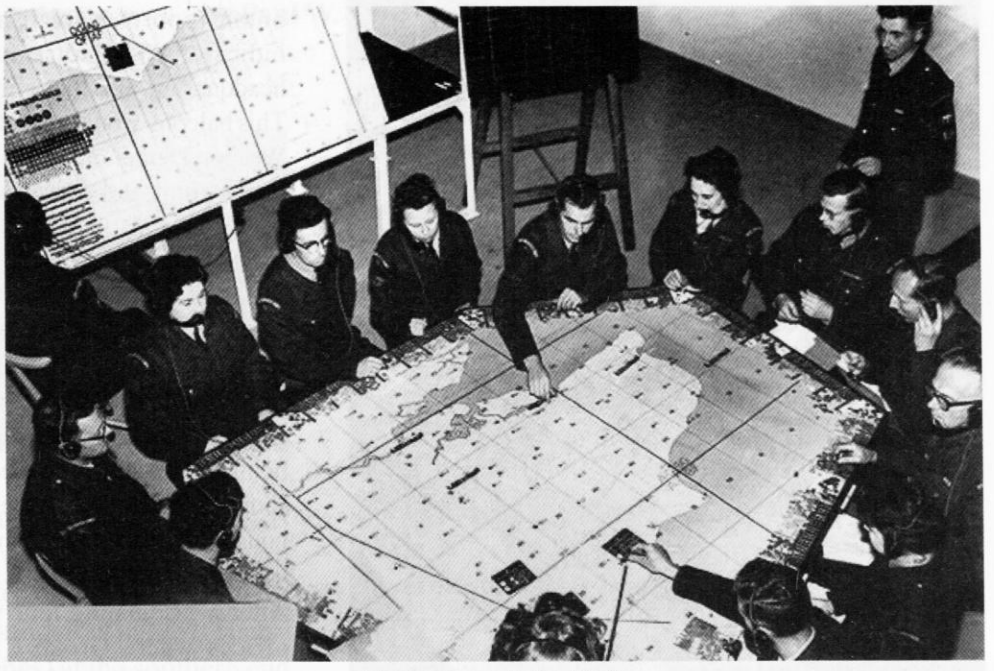
Trip Report – ROC 1 Group HQ Maidstone

by Thomas Carriage

Saturday 23 October, 2010 saw myself and twelve other Sub Brit members visit 57 London Road, Maidstone, site of the former 1 Group Royal Observer Corps Headquarters. This was the first trip I have organized as a member of Sub Brit, and the first trip for a few of the other attendees too.

In 1939, 57 London Road was requisitioned for 1 Group Observer Corps Headquarters (not the *Royal* Observer Corps until 1941), and named Fairlawns. The 1950s saw the building downgraded to a training centre for 19 Group, Beckenham. In 1960 the protected accommodation to the rear of Fairlawns was opened, and the site became 1 Group Headquarters once again. In 1976 the house was renamed Ashmore House, in memory of Major Ashmore, founder of the Observer Corps, but in 1991 came the ROC stand-down, and the headquarters closed.

This bunker was one of 31 planned group headquarters, of which only 25 were built and in use for any significant amount of time. The role of the headquarters was to establish the height, power and position of any nuclear explosions in the area; information collected from the surrounding ROC posts would be triangulated and integrated. Data collected from each post consisted of radiation levels using Radiac survey meters, bomb intensity from bomb power indicators and direction using ground zero 'pinhole' cameras. After collation, bomb position and fallout tracks would be plotted and distributed to adjacent ROC Headquarters and local Home Office sector controls.

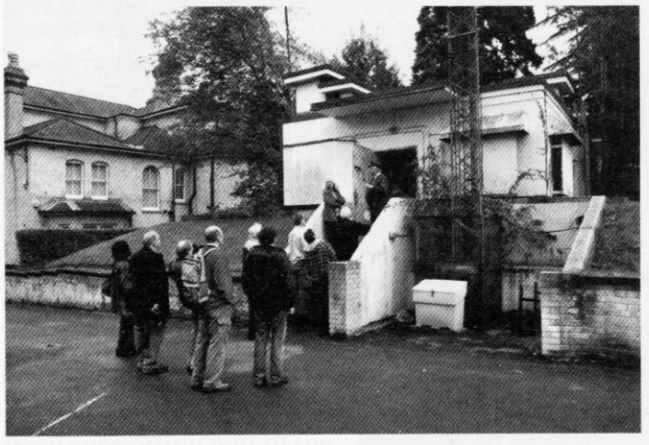


Control room in the 1960s

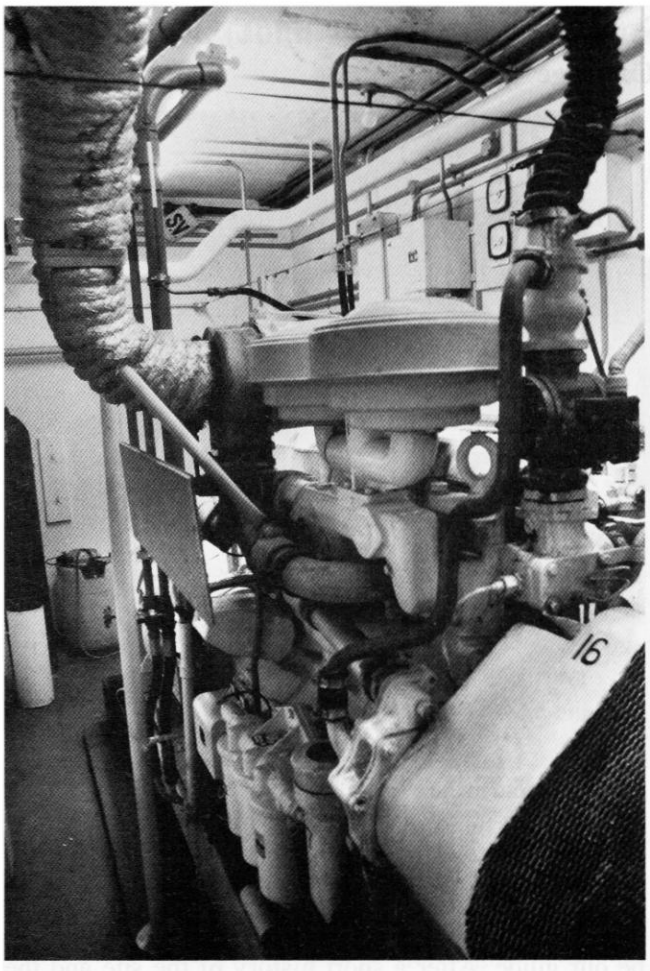
Now owned by the local firm of Branchers Solicitors, the bunker can be opened for tours, which are kindly arranged by Carol Vizzard of Maidstone Museum. On this occasion, Group Captain McCarthy was available to be our guide. After a short history of the site and the ROC, we were led to the bunker. Externally the bunker consists of a blockhouse set into a rectangular turf-covered earth mound, and is built to the same design as the twelve other semi-sunken style ROC headquarters, the rest being surface buildings. On top of this earth mound there is the original fire exit, consisting of an ROC post-style hatch. The fire exit was modified in the 1970s by adding stairs and a door and the pipe for the Radiac probe is still visible. Externally the blockhouse is in good condition except for a bit of crumbling paintwork; internally the building has sixteen rooms with approximately 1,020m^2 of floor space.

The entrance to the bunker is up a flight of stairs, through a blast door onto the top floor. The first floor consists of an air lock, decontamination room, aerosol filter room and radiator room for the generator. There is also a huge water tank, which would hold enough water for 30 days with 50 people in the bunker, based on an emergency consumption of a gallon per day per person. The tank is marked in both litres and gallons up to 1,560 gallons.

The ceiling above the stairs leading down to the middle level has had some water damage due to the roof leaking, but the owners have had the roof repaired in the last year, so no further damage should occur. At the bottom of the stairs leading down from the top level, there is a room with the sewage ejection system, common to all semi-sunken ROC headquarters. The corridor that splits



The group at the entrance. Photo by Thomas Carriage



Generator as it was left in 1991. Photo Thomas Carriage

this level in two leads to the fire exit at the far end. The first room in the corridor is the plant room, which still has the plant in place, all in working order. The generator room leads from this, and has a cabinet full of spares for the generator, and a carbon dioxide fire extinguishing system.

Back in the corridor again, on the left-hand side, there are male and female toilets (with all fittings removed), male and female dormitories (female dormitory was locked), and the officers' room. The second room on the right-hand side is the kitchen and canteen. The kitchen still has some fittings. The canteen has electrical switchgear at the rear of the room behind wooden panels. The small room next to the stairs leading down to the bottom floor used to house all the food supplies for the bunker.

The last room on the right-hand side is the control room balcony. Carol has placed around the sides of the balcony some pictures that were taken when the HQ was in use. The balcony would have originally had rotating boards around it, which held reporting details for each ROC post.

On the ceiling of the control room there are some interesting movable strip-light fittings that are on what looks like curtain rails. On the ceiling of the alcove (where bomb reports were triangulated), the bomb power indicator and Radiac tubes are visible (each group headquarters also had a full set of post instruments itself). This balcony would also have held the AWDREY (Atomic Weapon Detection Recognition and Estimation of Yield) display unit, if the HQ had one (Maidstone did not).

Until recently, the control room was filled with shelving to house files for the solicitors. This has now all been removed. On the bottom floor the radio room is split in two, the smaller room used to house a computer, and has additional environmental control. It is now filled with the disassembled racking from the control room. We were told the room is a Faraday cage, to stop the computer being affected by any electromagnetic pulse. There is a soundproofed room to the rear of the control room which housed all the telex equipment, and would have been very hot and noisy when in use. This is now filled with racking.

After a fascinating tour we were led to the solicitors' offices where Group Captain McCarthy's wife had generously laid on refreshments for the party. Our thanks to all concerned for a most interesting visit.

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Control room in 2002 when the bunker was still used for storage. Photo Nick Catford

The collapse in 1974 of the Tyler Hill (Canterbury & Whitstable Railway) tunnel below the University of Kent at Canterbury, Kent

by Paul W. Sowan

Train emerging from the south portal

Land at Tyler Hill, north of Canterbury city centre, was purchased for the new university in 1963, which purchase included the greater part of the Tyler Hill railway tunnel abandoned by British Rail in 1952. Thirty-four metres (114 feet six inches) at the southern end had previously been sold by British Rail to Canterbury Corporation for the Archbishop's School on 1 November 1955. The school walled-off their small section of the tunnel at both ends, and used the space for storage. During the course of a Subterranea Britannica Study Weekend members (with permission) viewed the locked door at the south portal.

Until the sale in 1963, British Rail engineers made periodic inspections of the disused tunnel. Thereafter, such inspections were continued by or on behalf of the University. As a result of an inspection in October or November 1973 remedial work was recommended below the site of the University's Cornwallis Building, and tenders for work were being obtained. Before any support work could be commenced, however, inspections of the tunnel revealed further warning signs from February 1974 onwards, and on 11 July that year a mass of London Clay which had been supporting part of the new building suddenly subsided, some by as much as 0.7 metre. Collapse of the building seemed imminent, and those parts at risk were demolished. Expert advice was summoned, and Professor A.W. Bishop of Imperial College prepared, during the year following the collapse, a capacious technical report on the likely cause and recommended measures for the remediation of the damage and prevention of future problems.

The Canterbury & Whitstable Railway

The Canterbury & Whitstable Railway opened on 3 May 1830, with a single station at each at those places. That part through the tunnel under Tyler Hill, being on a gradient of about one in fifty-four, was worked by stationary winding engines until 1836, when sufficiently powerful steam locomotives became available. The railway passed into the control of the South Eastern Railway in 1846, when the original termini were closed and replaced by nearby SER stations (what is now Canterbury West having been opened on 6 February that year).

The Tyler Hill tunnel

The tunnel, opened as it was on 3 May 1830, predates the short Crown Street tunnel at Liverpool which formed the western end of the Liverpool & Manchester Railway,

North portal in November 1982. Photo Nick Catford

opened on 15 September the same year. It is, therefore, the oldest railway tunnel in the world to convey passenger trains. George Stephenson [1781 - 1848] was, nominally, the engineer, although John Dixon [1796 - 1865] had day-to-day supervision of the construction work.

It is a single bore tunnel, designed for a single line of rails, and is inclined downwards to the south at a gradient of 1 in 54. The width and height, both somewhat variable even before distortion in various places, are of the order of twelve feet, and the length has often been stated (amongst other figures) as 828 yards (764.3 metres). Modern measurements suggest 835.25 yards (771 metres). There are ten refuges or recesses in the east wall where men working on the track could shelter from passing trains. The profile is of perpendicular side walls and a semicircular arched ceiling and a flat floor at the southern end, but there is an ovoid cross-section with an invert (thrust-resisting floor) at the upper end. The

South portal

differing profiles are thought to reflect the geological strata through which the tunnel was driven: London Clay in the upper part, Woolwich Beds further south, and Thanet Sand at the lower end. The entire tunnel appears to have been driven from the portals, the two drives being commenced from the ends in 1825 and meeting in May 1827. The structure is brick throughout, the lining being four half-bricks (eighteen inches or 0.45m) thick. There appear to be no spoil-extraction shafts, and no ventilation shafts were provided. In this exceptionally cramped space (locomotives with unusually short funnels had to be employed) both locomotive crew and passengers endured exceptionally smoke-laden air. All rail services ceased in 1952 (with a brief reopening as an emergency diversionary route in 1953 as a result of flooding elsewhere on the network).

The collapse and its mechanism and remediation

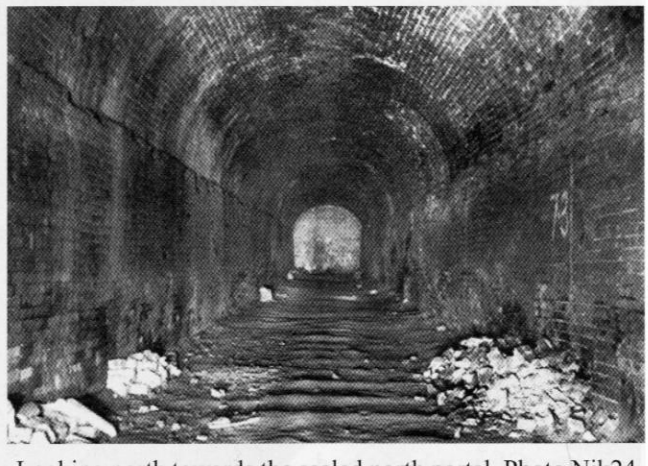
The collapse occurred over a length of tunnel extending from 260 to 292.5 yards (240 to 270 metres) inwards from the north portal. The most likely cause was found to be a failure of the brick lining followed by the formation of a cavity above the crown of the arch, clay having run into the tunnel through the breached side-wall. Following this, a solid more-or-less cylindrical mass of clay suddenly subsided en masse, thus removing support from the foundations of the Cornwallis building. Other proposed causes and collapse mechanisms were considered and dismissed as improbable, including the after-effects of a supposed nearby World War II bomb, and a gradually upward-migrating void.

Current state of the tunnel and plans for its future

A considerable length of tunnel was infilled, from an unstated point inside the north portal to a point about 299 (276 metres) feet in from there. The immediate collapse area was also subjected to injection grouting, to ensure a complete absence of voids below the re-built Cornwallis building. Thus around 240 feet (227 metres) at the south end remains open, as presumably does the school's short section.

Judging by the massive steel fence obscuring the view of the north portal, in a cutting reached by a well-marked footpath and steps from the northern edge of the University Campus, a length of unfilled tunnel remains here. Visitors have to be content with an information board. Much of the ten kilometre length of the Canterbury & Whitstable Railway has now been designated a public right of way, the 'Crab & Winkle' trail.

There have been recurrent suggestions that the tunnel might be re-opened as a cycle route. This it seems would call for a massive civil engineering operation to clear, strengthen, pave, and light the tunnel. However it has been reported that the project is 'technically feasible' (although whether affordably or not is not stated!).



Looking north towards the sealed north portal. Photo Nik24

Radon Underground

by Paul W. Sowan

Introduction

Alpha radiation (in fact relatively heavy slow-moving positively charged helium ions) is fairly harmless externally, as it cannot penetrate the skin. But internally, it can be extremely damaging, and has been identified as an important cause of cancer. It affects the tissue of the lungs as a result of breathing in air containing radon gas.

What is radon?

Radon is a naturally occurring, very dense, radioactive, but chemically inert elementary gas. It is potentially found in dangerously high concentrations in underground atmospheres where air circulation is restricted, including natural caves, mines, tunnels, wells, and also in cellars and under-floor spaces in buildings. The gas is given off by the radioactive decay of uranium in uranium-bearing minerals which occur naturally, albeit in minute quantities, in a very wide range of rocks, although the highest concentrations are generally in granites, gneisses, and other mineralogically related igneous or metamorphic rocks.

Radon, atomic number 80, has at least 27 known isotopes (Kaye & Labey, 1986), all of them radioactive, with atomic masses ranging from 200 to 226. These have half-lives (all of them very short) from 2.7×10^{-7} seconds (Rn 214) to a maximum of 3.824 days (Rn 222)

It is radon-222 which is of concern. Radon-219 (half-life 3.96 seconds) also called actinon, and radon-220 (half-life 55.6 seconds) also called thoron, are given off by the elements actinium and thorium respectively. However, these radon isotopes have such short half-lives that they effectively decay to non-gaseous daughter elements before they have a chance to escape from the actinium- or thorium-bearing minerals.

Why is radon a problem?

Ridley (1979) describes Radon, in itself, as 'relatively harmless.' It is a chemically inert gas, and as a constituent of inspired air is simply exhaled again. However, being radioactive, it undergoes radioactive decay, its atoms thus (apart from emitting positively charged alpha particles) converting to sub-microscopic particles of solid radioactive daughter elements which can adhere to the lung walls. Similarly, these sub-microscopic particles floating about in mine air, or attached to already-existing dust particles floating about, can be inhaled and trapped by the sticky lining of the lungs.

Radon-222 is given off during the radioactive decay of one of the decay-products of uranium and, having (in comparison with the other radon isotopes) a relatively long half-life (3.824 days as noted), has a chance to escape from the mineral crystals containing these before in turn decaying to other solid radio-isotopes.

When radon-222 atoms in turn disintegrate, or decay, they lead to a whole series of further radioactive isotopes of various elements, having half-lives from as short as three minutes to as long as 16.5 years, before ultimately turning into a non-radioactive isotope of lead. While this is going on, your lung tissue is being subjected at very close range to all three sorts of radiation – alpha, beta, and gamma.

Can radioactivity be avoided altogether?

No! Quite apart from incoming cosmic radiation, we are all of us inherently and unavoidably radioactive anyway. Potassium salts, essential components of blood plasma and cell fluids, contain the stable potassium-39 isotope, but also 0.0117% of the radioactive potassium-40, which has a half-life of 1.28×10^{9} years! You can't run away from that! Theoretically, you *could* remove all the potassium-40 from your food before you eat it, but you'd doubtless need the sort of huge and incredibly expensive isotope separation factory erected during World War II to make the atom bomb a practicable reality. And it would spoil your dinner.

Those of us who were around before nuclear weapons testing went underground will all have, firmly locked into our bones, a certain amount of strontium-90 (so similar to the essential calcium that your body builds it into bones and teeth just as it does the latter element), and various other long-half-life radio-isotopes. Even if you missed air-burst or ground-burst nuclear tests, you won't have escaped another dose of strontium-90 from the Chernobyl disaster in 1986! Strontium-90 has a half-life of 28.8 years, so you have that long to wait before the stuff in your bones has reduced by half, and as long again before it has reduced by another half (of the first half) so you can't really get away from it.

During the Cold War, when a nuclear attack at times seemed terrifyingly likely, about the only popularly known defence against radiation (apart from lead underpants for aspiring parents-to-be!) was potassium iodide tablets. If your body takes in a higher than usual amount of iodine compounds, you dilute the amount of radioactive iodine-129 (half-life 1.57×10^{7} years) taken up by your thyroid glands. Naturally occurring iodine (another element essential in small quantities for life to continue) is 100% iodine-127. I don't recall anybody wondering if potassium iodide might have the same inhibiting effect on sex-drive that the chemically very similar potassium bromide supposedly had (was it really added to the squaddies' tea during the war?).

Where might be safest?

The highest radon readings in the UK tend to be found in areas with a great deal of granite at the surface, such as Devon and Cornwall. Or with (it is thought) significant

masses of granite not too far below the surface, such as the Peak District. Out in the open air, the risk is negligible, as radon is rapidly diluted by air movements. But in pooled still air (remember radon is a very high-density gas) it will tend to accumulate. Well ventilated subterranean places without atmospheric 'sumps' are to be preferred to the bottoms of shafts or the ends of dead-end tunnels. And a damp hole in the ground would be better than a dusty dry one, as the radioactive daughter-isotopes are more likely to stick to damp particles settling on the floor.

Bear in mind that minute grains of uranium-bearing minerals, eroded in the first place from granites or gneisses, will be carried along with ordinary sand grains (quartz from the same sources) and so be built into ordinary sandstones, sandy limestones, and other sedimentary rocks. The minerals in question will not be pure uranium compounds such as the uranium ores autunite, carnotite, or pitchblende. Traces of uranium (chemically resembling, say, chromium) are built into the crystals of other heavy-metal compounds. Thus, the Folkestone Sand, into which the 'caves' and mines at Reigate are excavated (and where radon is certainly detectable underground) contains (apart from about 99% pure quartz) traces of iron and chromium oxides and iron- or chromium-bearing minerals, which would certainly host any odd uranium atoms floating about at the time of crystallisation. The sand at Reigate is known to contain, amongst other trace minerals, ilmenite, kyanite, magnetite (an iron oxide), muscovite mica, rutile, spinel, staurolite, and tourmaline in readily detectable (if small) quantities.

The Blackheath Pebbles beds of south and southeast London have been shown to contain all of these (except the mica), and also amphiboles, anatase, andalusite, brookite, chloritoid, epidote, garnet, glaucophane, and zircon. Several of these mineral species (especially possibly the garnet) would be ideal hiding places for stray uranium atoms!

When Peter Laurie (1970) misinterpreted the radiation warning signs he saw on the perimeter fences at RAF Chilmark (Wiltshire) as possibly indicative of the presence there of nuclear weapons, he was unaware that the radioactivity (and the radon) in the underground storage areas was monitored, and emanated from just such minerals in the natural rock. In fact the air in the underground quarries at Chilmark may well contain no more radon than the air in the sand caves of Reigate (in which town Laurie was born in 1937!).

Conclusions: what is the risk?

As with all questions of radiation, there is no zero-risk option! But it is sensible to minimise avoidable risk. Apart from preferring damp but well-ventilated underground spaces, the other crucially important factor is to limit exposure time. Underground radon is really only a serious problem to those exposed to it for lengthy periods of time, such as the persons employed more or less all-day every-day to move and stack bombs (conventional explosives only!) underground at Chilmark; or full-time cave guides or caving instructors.

Even so, you are far more likely to be squashed under a bus than die of radon-induced cancer. On the other hand, it is statistically established that ordinary householders living in well-insulated (draught-free) houses in high-risk areas of the UK do suffer reduced life-expectancy in comparison with the inhabitants of, say, draughty old barns on wind-swept coastal cliffs!

To sum up – don't hang about in deep, airless, dusty old holes in the ground, especially in Cornwall!

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